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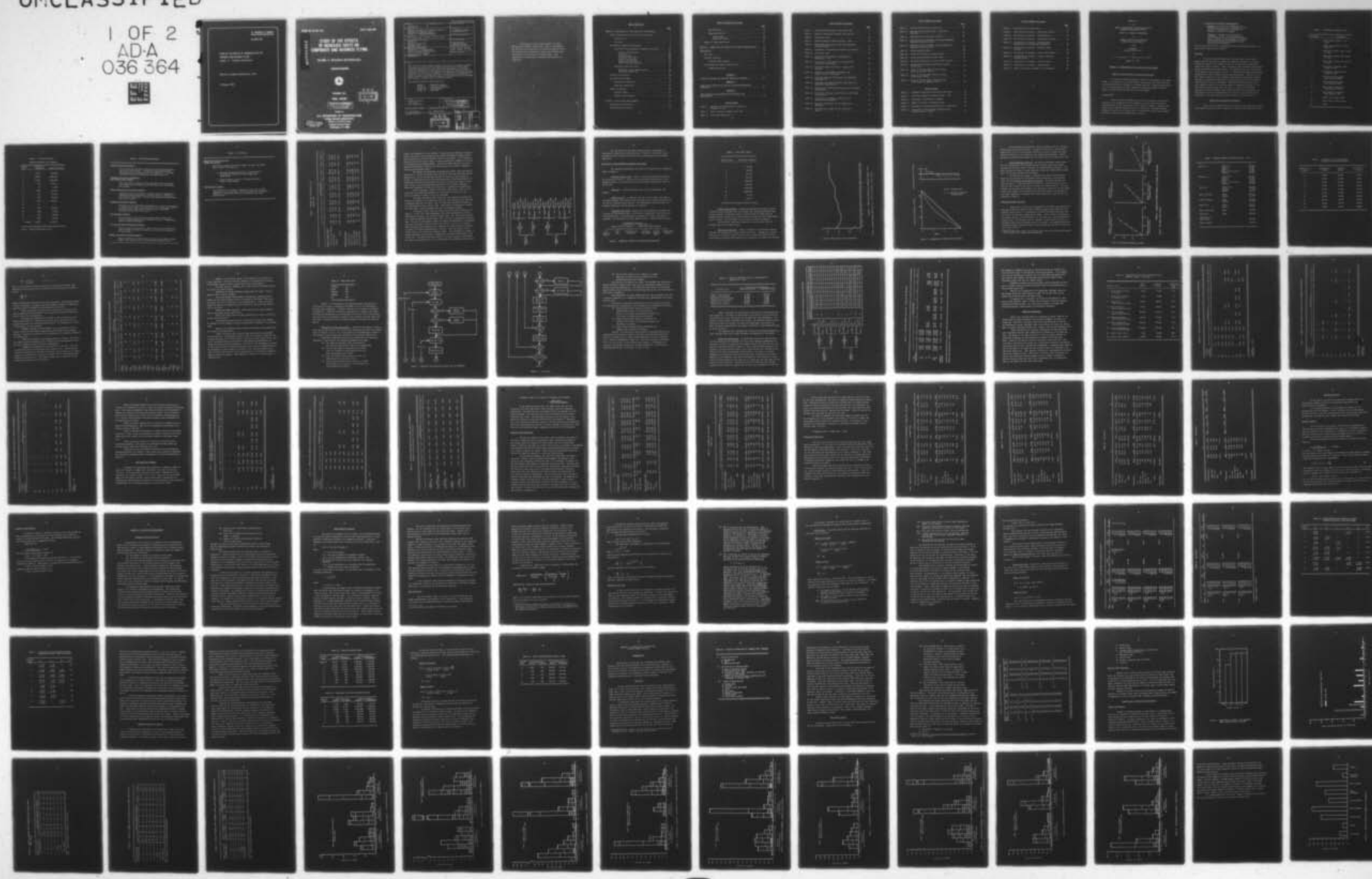

U.S. DEPARTMENT OF COMMERCE
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STUDY OF THE EFFECTS OF INCREASED COSTS ON CORPORATE AND BUSINESS FLYING

VOLUME II. RESEARCH METHODOLOGY

BATTELLE COLUMBUS LABORATORIES, OHIO

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STUDY OF THE EFFECTS OF INCREASED COSTS ON CORPORATE AND BUSINESS FLYING

VOLUME II. RESEARCH METHODOLOGY

Battelle-Columbus

NOVEMBER 1975

FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Aviation Policy
Aviation Forecast Branch
Washington, D.C. 20591

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16. Abstract

This report, in four volumes, presents the results of research intended to enhance the utility of the original General Aviation Cost Impact Study (DOT-FA74WA-3118) by (1) identifying subcategories of business/corporate operators with varying effective after-tax sensitivities, (2) redefining the empirical cost impact relationships for business/corporate flying by using an expanded data base, and (3) providing information to permit greater insight into the nature of the business fleet by examining the financial characteristics of corporate owners.

The volumes included in this report are:

Volume I - Executive Summary
Volume II - Research Methodology
Volume III - Planning Guide
Volume IV - Data Base

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TABLE OF CONTENTS

go to p iv

TABLE OF CONTENTS (Continued)

from p iii

APPENDIX A

APPENDIX B

APPENDIX C

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

FINAL REPORT

on

STUDY OF THE EFFECTS OF INCREASED COSTS ON CORPORATE AND BUSINESS FLYING

VOLUME II: RESEARCH METHODOLOGY

to

FEDERAL AVIATION ADMINISTRATION
OFFICE OF AVIATION POLICY

from

BATTELLE
Columbus Laboratories

by

R. F. Porter, M. A. Duffy, and R. W. Cote

August 12, 1975

CHAPTER 1: DEVELOPMENT OF COST SENSITIVITY COEFFICIENTS

General Aviation Aircraft Activity and Cost Data

In order to extend and expand the results of the previous Cost Impact study, it was necessary to compile aircraft activity and cost data within the business/corporate user category for calendar year 1972. Aviation Data Service, Inc of Wichita, Kansas, was again engaged by Battelle-Columbus to provide support in establishing the data base for this program.

Activity Data

Activity within the business/corporate user category was measured in terms of two fundamental activity measures: (1) the number of aircraft (ownership) and (2) the annual hours flown (volume of flying). Aviation Data Service (ADS) compiled information from its data files to provide activity measures for each of 13 aircraft types. The business/corporate user category pertains to the following standard FAA definition.

- Business and Corporate Transportation

  Business - Any use of an aircraft not for compensation or hire by an individual for the purposes of transportation required by a business in which he is engaged.

  Corporate - Any use of an aircraft by a corporation, company, or any organization for the purposes of transporting its employees and/or property not for compensation or hire and employing professional pilots for the operation of the aircraft.

The activity data for 1972, as provided by ADS, are presented in Table 2 for the aircraft types defined in Table 1.

Cost Data

The costs associated with owning and operating various types of general aviation aircraft are regarded as important variables to be used in forecasting changes in the number of aircraft in operation and the annual utilization hours in service. Major cost centers were identified and examined during the previous Cost Impact Study. The definitions of cost centers used in the present study are given in Table 3. Only the description of Annualized Investment cost center differs from the previous program. This basic set of cost centers includes the cost elements associated with owning and operating aircraft, and provides flexibility for including new types of cost elements within each cost center as necessary. Ownership and operating cost data, also compiled by ADS for each aircraft type, are presented in Table 4. For definition of each aircraft type, see Table 1. Values for Annualized Investment have been deleted, since a major objective of this program is to obtain a more realistic representation of this cost center than was used previously. Also note that each of these values is a before tax cost.

Derivation of Annualized Investment

Two of the most complex areas of business aircraft operation involve the methods used by a business to account for aircraft operating costs and to

TABLE 1. DEFINITION OF AIRCRAFT TYPES

Type Number	Definition
1	Single-engine pistion, 1 to 3 place
2	Single-engine piston, 4 place and over
3	Twin-engine piston, under 12,500 lb TOGW
4	Twin-engine piston, over 12,500 lb TOGW
5	Multi-engine piston, over 12,500 lb TOGW
6	Twin-engine turboprop, under 20,000 lb TOGW
7	Twin-engine turboprop, over 20,000 lb TOGW
8	Twin-engine turbojet/fan, under 20,000 lb TOGW
9	Twin-engine turbojet/fan, over 20,000 lb TOGW
10	Multi-engine turbojet/fan, under 20,000 lb TOGW
11	Multi-engine turbojet/fan, over 20,000 lb TOGW
12	Rotary wing, piston engine
13	Rotary wing, turbine engine
14	Other

TABLE 2. 1972 ACTIVITY DATA

Business/Corporate User Category

Aircraft Type	Aircraft in Operation	Hours of Service
1	3,151	340,528
2	22,942	4,045,822
3	11,640	3,363,960
4	779	158,137
5	31	4,588
6	1,002	525,048
7	213	159,963
8	538	305,046
9	405	254,745
10	--	--
11	220	135,740
12	336	87,696
13	236	86,848
14	860	70,520
Totals	42,353	9,538,641

Source: Aviation Data Service, Inc.

TABLE 3. COST CENTER DEFINITIONS

Fuel and Oil Costs ($/hour)

Fuel and oil cost per hour are based on the average consumption rate at 75 percent power. Airframe and engine manufacturers recommended fuel type were used for all calculations. The Fuel and Oil Cost Center includes state and federal fuel tax.

Airframe and Avionics Maintenance and Overhaul Cost ($/hour)

This cost center includes all labor and parts costs associated with scheduled and unscheduled airframe and avionics maintenance and overhaul.

Engine Maintenance and Overhaul ($/hour)

Engine maintenance and overhaul includes costs for scheduled and unscheduled engine maintenance, overhaul, 100 hour, 1000 hour, and/or annual inspections. Includes also midpoint and cycle costs for turbine engines.

Annualized Investment ($/year)

The purpose of the annualized investment cost center is to represent an annual dollar amount for ownership cost of the aircraft itself. A discounted cash flow analysis has been used to determine equivalent annual (after tax) costs.

Hull Insurance ($/year)

Hull insurance cost is the annual premium paid to insure the aircraft against damage while in motion or at rest. A deductible amount is normally included.

Liability and Medical Insurance ($/year)

Liability insurance premiums are paid to insure the aircraft owner against damage to persons or property by reason of his operation of the aircraft.

Hangar, Storage and Tie Down ($/year)

Hangar, storage and tie down rates are averaged from known regional hangar rates, parking fees, and manufacturer suggested rates.

TABLE 3. (Continued)

Federal Registration Fee and Weight Tax ($/year)

The Federal registration fee and weight tax went into effect July 1, 1970. The rates are:

- Reciprocating powered aircraft - $25 plus $0.02 per pound for aircraft of gross weight over 2,500 pounds.

- Turbine powered aircraft - $25 plus $0.035 per pound of gross weight.

Miscellaneous ($/year)

Miscellaneous costs include allowance for the state aircraft registration fees, training, catering, landing fees, navigation materials, airworthiness directive requirements and minor modifications.

TABLE 4. VARIABLE AND FIXED COSTS, 1972
(Before Tax)

	Aircraft Type*									
	1	2	3	6	7	8	9	11	12	13
Variable Costs ($/Hr)										
Fuel & Oil (Inc Taxes)	4.95	7.37	18.20	34.70	111.90	141.13	184.31	292.88	6.74	12.43
A/F & Av Main	1.82	3.00	9.50	20.93	91.50	51.05	120.29	121.71	10.49	15.89
Eng Main	1.36	2.11	9.29	21.59	16.25	42.30	64.29	93.05	3.67	17.46
Total	8.13	12.48	36.99	77.22	219.65	234.48	368.89	507.64	20.90	45.78
Fixed Costs ($/Yr)										
Hull Insurance	899	1,140	2,470	9,362	22,500	12,454	24,063	22,500	6,090	11,875
Med & Lia Ins	175	306	360	1,500	3,600	1,380	1,500	3,940	350	660
Hangar & Tie Down	554	638	1,391	2,833	12,325	9,107	10,060	11,836	625	827
Fed User Charges	25	76	148	407	1,416	613	1,331	1,513	29	137
Misc Fixed Costs	93	125	208	2,368	6,400	4,373	9,182	9,280	122	204

*For definition of aircraft type, see Table 1.

finance the acquisition of new aircraft. These areas are important considerations in the study of cost impact because choice of methods can make significant differences in cash flow and net income to the company. In the previous General Aviation Cost Impact study, it was not possible to examine the details of financing and accounting methods. Instead, an index was used to indicate behavioral responses of business aircraft operators as a group to changes in operating and ownership costs.

This index, the Annualized Investment Cost Center, was very grossly defined as the aircraft purchase price plus sales tax times the annual percent depreciation. No tax savings were realized nor were any crew salaries included. A prime objective of this second phase was to identify possible user subcategories within the business/corporate user category according to ownership, finance, and accounting characteristics, and to define a realistic Annualized Investment for each user subcategory - aircraft type combination.

Table 5 presents a matrix of 240 such combinations. Only ten aircraft types are considered because cost center data for types 4, 5, 10, and 14, as defined in Table 1, were not available.

The first distinction made within the user category is whether the aircraft is corporate or noncorporate operated. This distinction is important in applying effective tax rates. Next is a division according to whether or not a professional flight crew is used. Three means of acquiring an aircraft are identified: lease, mortgage financing, and outright purchase.

For those aircraft that are leased, two options were initially considered. In the "wet" lease arrangement, the lessor provides the aircraft, maintenance, insurance, and often the flight crews. The "dry" lease provides for a specified monthly rental payment for 5 to 8 years, depending on aircraft type. The size of the payment, which is entirely tax deductible, is determined such that the lessor receives an effective interest rate of 2 to 3 percent above the going prime interest rate. Normally, a 1-month payment is required in advance; no other downpayments are involved. Thus, the initial out-of-pocket costs to the lessee are relatively small. The investment tax credit is usually passed on to the lessee, allowing him a sizeable tax writeoff in the first year. The lessee also has an option to buy the aircraft at the end of the lease term, generally for 7.5 to 10 percent of the original purchase price.

TABLE 5. MATRIX OF ANNUALIZED INVESTMENT COST CENTERS

				Aircraft Type									
				1	2	3	6	7	8	9	11	12	13
Privately Owned	Non-Professional Crew	Lease	Dry										
			Wet										
		Finance	Accel										
			St. line										
		Own	Accel										
			St. line										
	Professional Crew	Lease	Dry										
			Wet										
		Finance	Accel										
			St. line										
		Own	Accel										
			St. line										
Corporate Owned	Non-Professional Crew	Lease	Dry										
			Wet										
		Finance	Accel										
			St. line										
		Own	Accel										
			St. line										
	Professional Crew	Lease	Dry										
			Wet										
		Finance	Accel										
			St. line										
		Own	Accel										
			St. line										

For the finance and outright purchase options, two methods of accounting for depreciation were considered. These are referred to as the straight-line and accelerated schedules and are discussed in the following subsection.

Structure of the Annualized Investment Cost Center

The Annualized Investment cost center is a function of the parameters shown in Figure 1.

Aircraft Purchase Price. Data for 1972 were obtained from ADS and are presented in Table 6. The price for a particular aircraft type is the weighted average of the prices for each make and model contained in that type during 1972.

Sales Tax. A national average sales tax of 5 percent has been assumed.

Income Tax Rate. A corporate tax rate of 50 percent, comprised of 48 percent Federal and 2 percent state and local taxes, is used in determining the tax for corporate owned aircraft. For noncorporate owned aircraft, the personal income tax rate was placed at 36 percent.

Investment Tax Credit. During 1972, the investment tax credit was 7 percent of the purchase price. This credit is deductible in the first year of operation only. If the aircraft is not kept for 7 years, the credit is prorated. The investment tax credit applies only to corporate-owned aircraft.

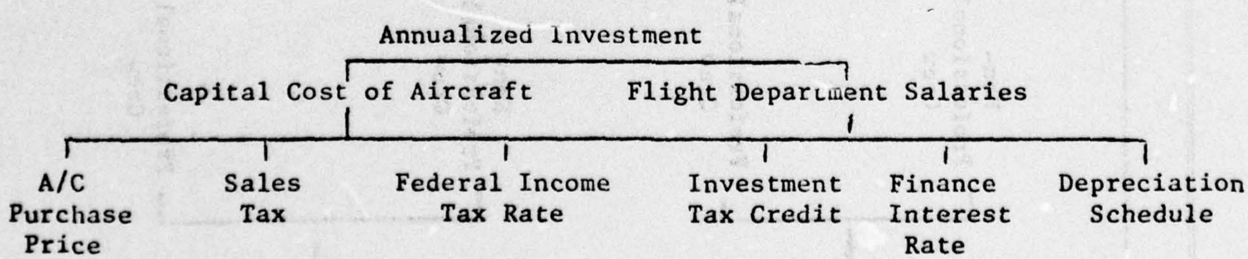

FIGURE 1. PARAMETERS AFFECTING THE ANNUALIZED INVESTMENT

TABLE 6. 1972 RETAIL PRICE

Aircraft Type	1972 Price (Dollars)
1	$ 19,980
2	28,506
3	117,596
6	514,350
7	1,500,000
8	939,250
9	2,187,500
11	2,250,000
12	50,750
13	118,750

Finance Interest Rate. Information gathered from several aircraft financing sources indicates that the interest rate charge on mortgage loans for new aircraft is generally between 3 percent above the prime rate for turbine-powered aircraft, and 4 percent above the prime rate for single-engine piston aircraft. The 1972 prime rate, by month, is given in Figure 2.

The effective lease rate is generally 1 percent lower than the mortgage rate for the same aircraft.

Depreciation Schedule. Figure 3 indicates the differences between straight-line depreciation and an accelerated method. Although most corporations use an accelerated method of depreciation, costs associated with both accelerated and stright-line schedules were determined for comparative purposes.

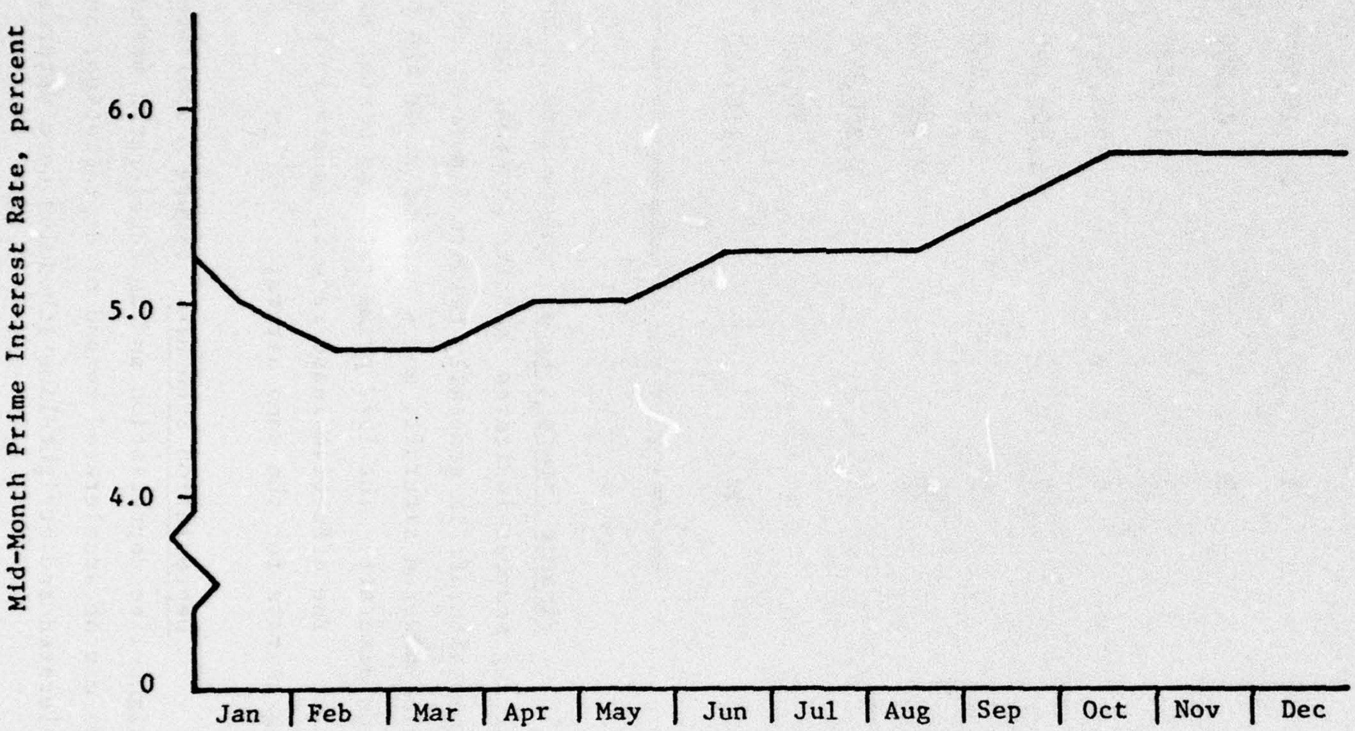

FIGURE 2. PRIME RATE CHARGED BY COMMERCIAL BANKS - 1972

Source: Federal Reserve Bulletin, No. 1, Vol. 59, January, 1973, pp A34.

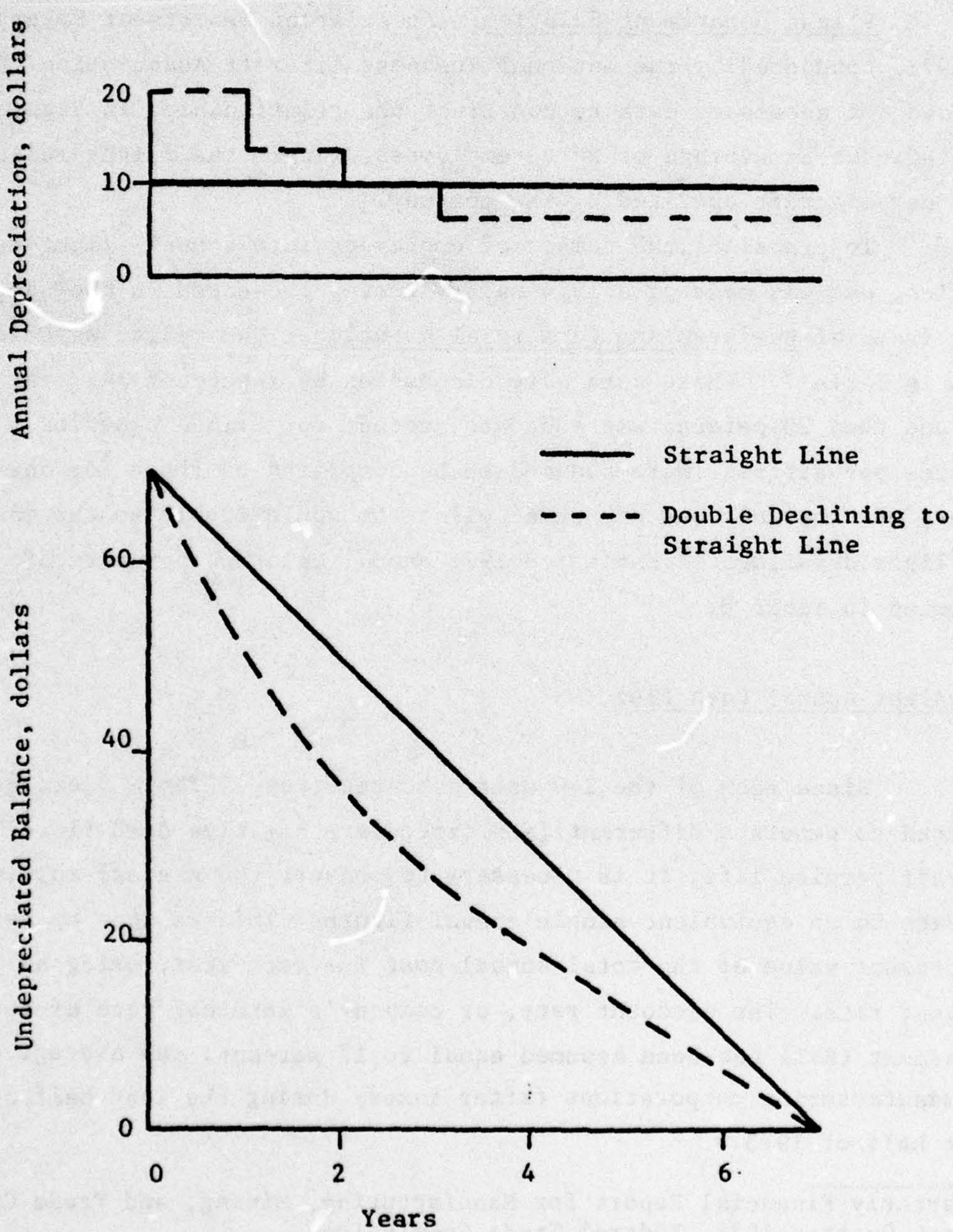

FIGURE 3. COMPARISON OF DEPRECIATION SCHEDULES

The accelerated depreciation schedule considered here is a "double-declining-to-straight-line" method. During the first half of the aircraft's (depreciable) life, the depreciation allowance is equal to twice the corresponding straight-line rate (applied to the undepreciated balance). Normal straight-line writeoff is applied over the second half of the aircraft's life.

Flight Department Salaries. An Aviation Department Salary Survey for 1972, conducted by the National Business Aircraft Association (NBAA), provided the necessary data to construct the relationships in Figure 4. The data indicate an average of three employees, within the flight-related department, per aircraft operated by the company.

To translate the number of employees into annual flight-related salaries, use was made of a 1974 salary survey presented in the September, 1974, issue of Business and Commercial Aviation. The median salaries are given in Table 7. These data were discounted by 7 percent per year back to 1972 and then 20 percent was added to account for fringe benefits. The three salaries per aircraft were assumed to be comprised of those for one maintenance worker, one copilot, and one chief pilot who would double as the manager of the flight department. Estimated 1972 annual salaries per aircraft type are presented in Table 8.

Equivalent Annual Cash Flow

Since each of the 240 user subcategories of Table 5 can generally be expected to generate different (and irregular) negative cash flows over the aircraft service life, it is necessary to convert the unequal multiyear flow of costs to an equivalent single annual figure. This is done by determining the present value of the total annual cost for each year, using an appropriate discount rate. The discount rate, or company's internal rate of return on investment (ROI) has been assumed equal to 12 percent, the average achieved by all manufacturing corporations (after taxes) during the last half of 1972 and first half of 1973.*

* Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations, First Quarter 1975, Federal Trade Commission.

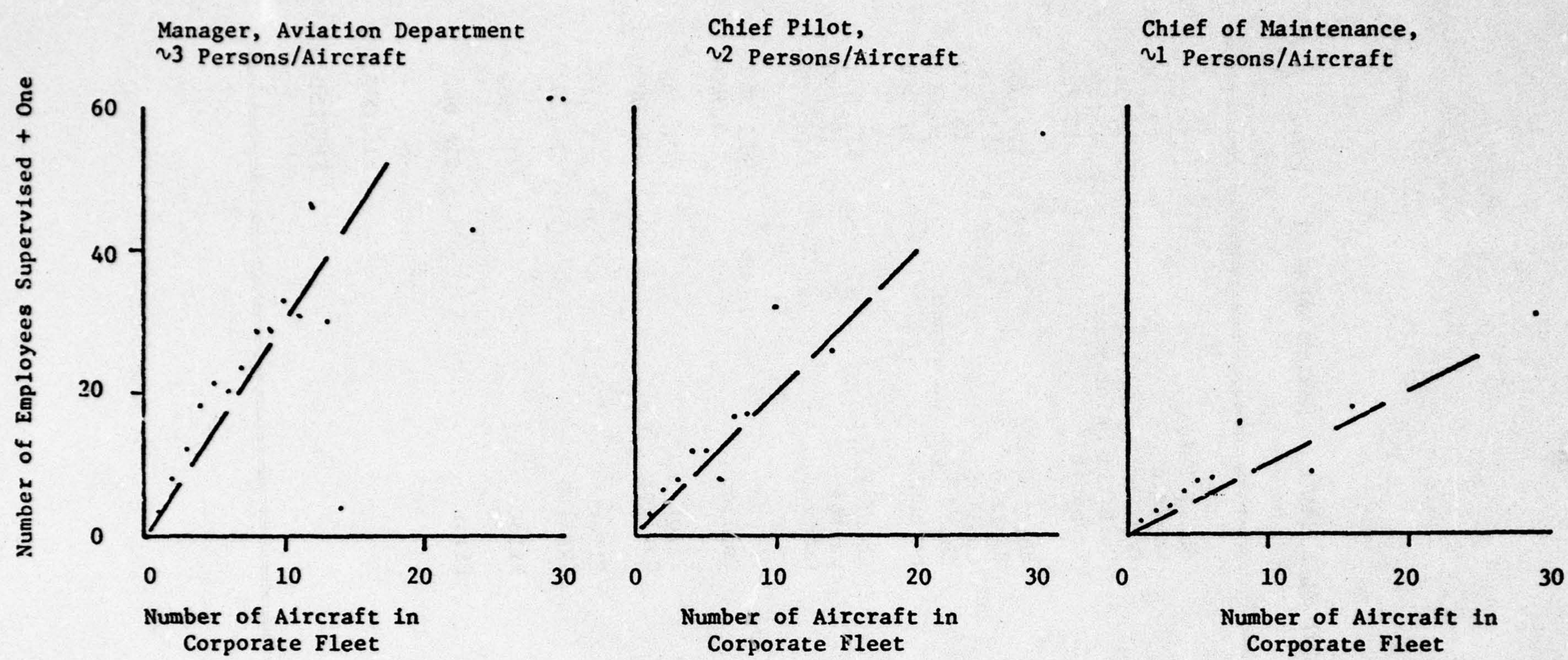

FIGURE 4. CORRELATION BETWEEN NUMBERS OF AIRCRAFT AND EMPLOYEES

Source: 1972 NBAA Salary Survey.

TABLE 7. NATIONAL SUMMARY OF MEDIAN SALARIES - 1974

Heavy Jet	Chief Pilot	$32,000
	Captain	27,000
	Copilot	17,546
	Chief of Maintenance	19,500
	Mechanic	13,860
Medium Jet	Chief Pilot	$25,000
	Captain	21,000
	Copilot	15,000
	Chief of Maintenance	16,000
	Mechanic	12,000
Light Jet	Chief Pilot	$21,000
	Captain	17,750
	Copilot	14,000
Heavy Turboprop	Pilot	$21,300
	Copilot	15,300
Light Turboprop	Pilot	$18,000
	Copilot	14,000
Cabin Twin	Pilot	$14,500
	Copilot	13,100
Other Fixed Wing	Pilot	$15,000
Helicopter	Pilot	$18,000
Other Chief of Maintenance		$15,000
Other Mechanic		$11,250

TABLE 8. 1972 ANNUAL SALARY PER AIRCRAFT
(INCLUDING 20% FRINGE BENEFITS)

Aircraft Type Category	Maintenance Salary	Co-Pilot Salary	Chief Pilot Salary
1.	11,800	13,800	13,800
2.	11,800	13,800	13,800
3.	11,800	13,800	15,200
6.	15,800	14,700	20,000
7.	15,800	16,100	22,400
8.	16,800	14,700	22,200
9.	16,800	15,800	26,300
11.	20,500	18,400	33,700
12.	15,800	18,950	18,950
13.	15,800	18,950	18,950

$$DF_i = \frac{1}{(1+ROI)^i} \qquad i = 1, 2, \ldots n$$

where n is the number of years of service for a particular aircraft type. Dividing the total present value of annual costs by the sum of the discount factors

$$\sum_{i-1}^{n} DF_i ,$$

yields the equivalent annual cost for each subcategory. This approach yields a valid, convenient, and simple comparison between alternatives, especially when they differ in original cost and expected service life.

Table 9 presents the input data, as a function of aircraft type, that is required in the calculation of an Annualized Investment figure for each of the 24 user subcategories.

The aircraft purchase price, ACPRICE, is from the 1972 data supplied by ADS (Table 6). Annualized investment values calculated in this program are based on new aircraft purchases only. No consideration is given to the purchase of used aircraft.

DOWNPAY represents the downpayment, as a percentage of purchase price, required by the finance company when establishing a term mortgage contract. Generally, 25 percent of the purchase price is required regardless of aircraft type.

TERM is the length of the mortgage contract in years. Note that it is usually possible to obtain 10 year financing on turbine-powered aircraft but only 5 years on piston aircraft and helicopters.

INTRATE is the interest rate realized on a term loan. The rate is normally adjusted to the current prime interest rate. Turbine-powered aircraft can generally be financed at 3 percent over the prime rate, single-engine piston aircraft at 4 percent over prime, and the remaining aircraft somewhere between the two. The values in Table 9 are consistent with the average 1972 prime rate of 5.25 percent.

TABLE 9. PARAMETERS FOR ANNUALIZED INVESTMENT CALCULATIONS

	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
ACPRICE ('72 $)	19,980	28,506	117,596	514,350	1,500,000	939,250	2,187,500	2,250,000	50,750	118,750
DOWNPAY (%)	25	25	25	25	25	25	25	25	25	25
TERM (Yrs)	5	5	5	10	10	10	10	10	5	5
INTRATE (%)	9.25	9.25	8.75	8.25	8.25	8.25	8.25	8.25	9.25	8.75
LSERATE (%)	8.25	8.25	7.75	7.25	7.25	7.25	7.25	7.25	8.25	7.75
LSETERM (Yrs)	5	5	6	8	8	8	8	8	5	6
LSEDOWN (Mo)	1	1	1	1	1	1	1	1	1	1
DISPRC (%)	7.5	7.5	9	10	10	10	10	10	7.5	9
PLTSAL ($/yr + 20%)	27,600	27,600	29,000	33,700	38,500	36,900	42,100	52,100	37,900	37,900
MNTSAL ($/yr + 20%)	11,800	11,800	11,800	15,800	15,800	16,800	16,800	20,500	15,800	15,800
LIFE (Yrs)	7	7	7	7	7	7	7	7	7	7
SERVICE (Yrs)	7	7	7	10	10	10	10	10	7	7
RESID (%)	20	20	20	20	20	20	20	20	20	20

LSERATE is the effective interest rate returned to the lessor on a lease agreement. This rate has been assumed to be 1 percent less than the corresponding interest rate on a term loan for the same aircraft.

The lease duration, LSETERM, varies from 5 years for smaller aircraft to 8 years for larger aircraft.

LSEDOWN is the normal prepayment required by the lessor. This is generally only 1 month's payment.

The actual monthly lease payment is based upon a disposal price, DISPRC, for the leased aircraft at the termination of the lease. This price is usually from 7.5 to 10 percent of the purchase price. In most cases the lessee can exercise an option to buy the aircraft at this price upon expiration of the lease.

PLTSAL and MNTSAL represent, respectively, the two pilot salaries and one maintenance salary from Table 8.

LIFE is the upper limit for asset depreciation in years, as allowed by IRS Code Section 167.

The expected service life for a particular aircraft type, SERVICE, is assumed to be the maximum of either the depreciable lifetime or the mortgage term.

RESID is the residual value to which the aircraft can be depreciated, as a percent of purchase price.

Table 10 presents other required input data which are independent of aircraft type. A state/local sales tax rate of 5 percent is applied to the original purchase price of the aircraft. The actual dollar amount of the sales tax is deductible from the corporation's/individual's adjusted before tax income for Federal income tax purposes. The tax rate for individuals is assume to be 36 percent while a nominal 50 percent rate is used for corporate purpose. An investment tax credit equal to 7 percent of the original purchase price (not including sales tax) can also be deducted from a corporation's income for Federal income tax purposes. This deduction is allowed in the first year of operation only.

TABLE 10. OTHER INPUT DATA

SALETAX	5%
PITAX	36%
CORPTAX	50%
TAXCRDT	7%
ROI	12%

Figure 5 is a flowchart of the computer program constructed for calculating the value of Annualized Investment for each user subcategory - aircraft type combination. A complete listing of the program is presented in Appendix A. There are three basic loops within the program; the innermost loop is incremented by year throughout the service life of the aircraft, the second loop is incremented through the ten different aircraft types, and the first, or outermost, loop is stepped through all possible user subcategories.

Refinement of User Subcategories. Because of the volume of calculation required and the fact that not all user subcategory-aircraft type combinations are likely to occur, the initial matrix of 240 combinations in Table 5 was reduced to include only those believed to be numerically significant.

Based upon judgmental factors, many combinations were completely eliminated. Specifically, the following assumptions were made:

(1) The number of privately owned (noncorporate) aircraft with professional crews is not significant.

(2) The aircraft owned by unincorporated business users are limited to single-engine piston and light twin-engine piston types.

(3) Only the lighter turbine-powered aircraft are operated by nonprofessional crews.

(4) The accelerated depreciation schedule is always used because of the increased tax advantage over the straight-line schedule.

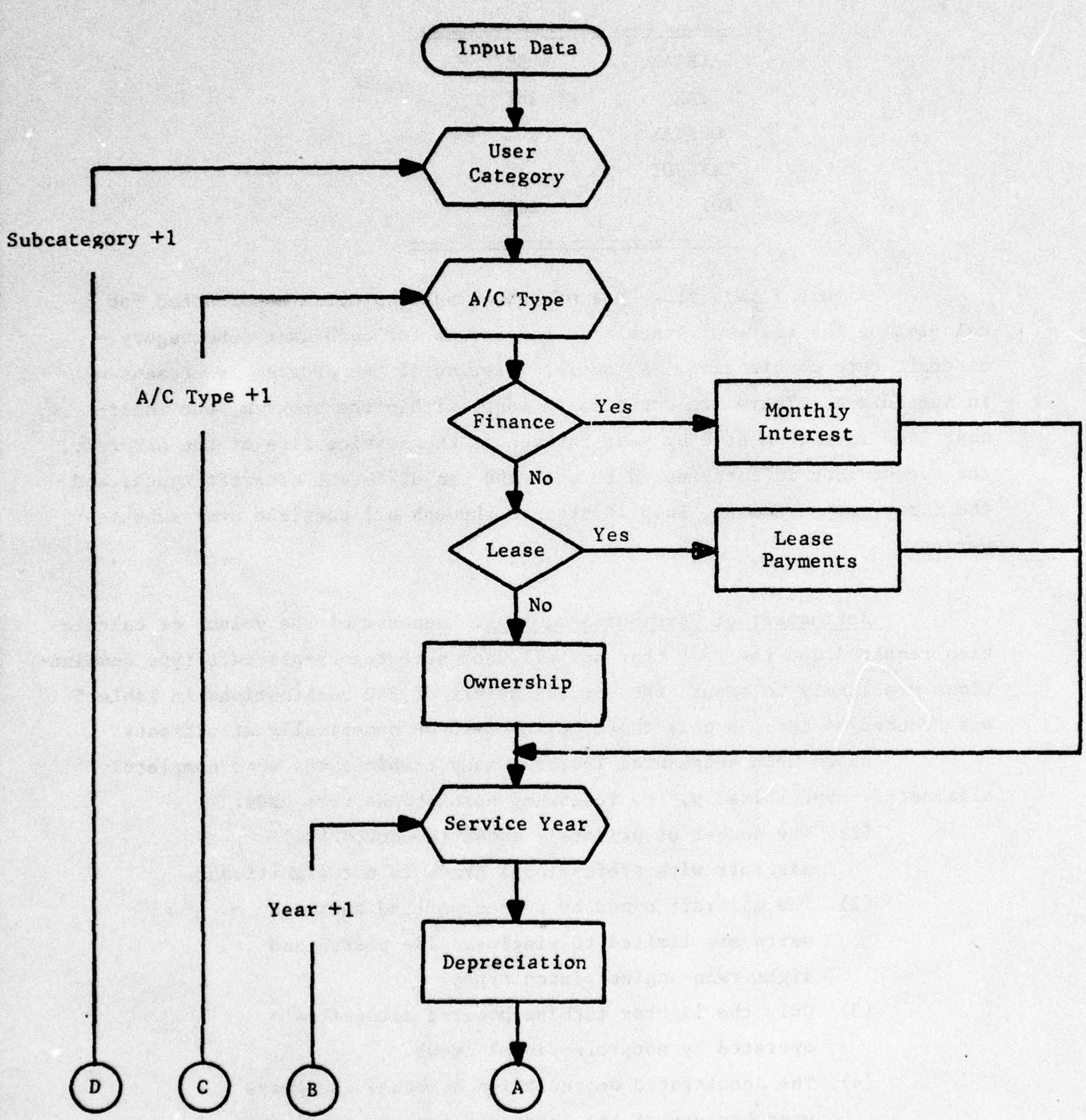

FIGURE 5. FLOWCHART FOR CALCULATING ANNUAL COST OF OWNERSHIP

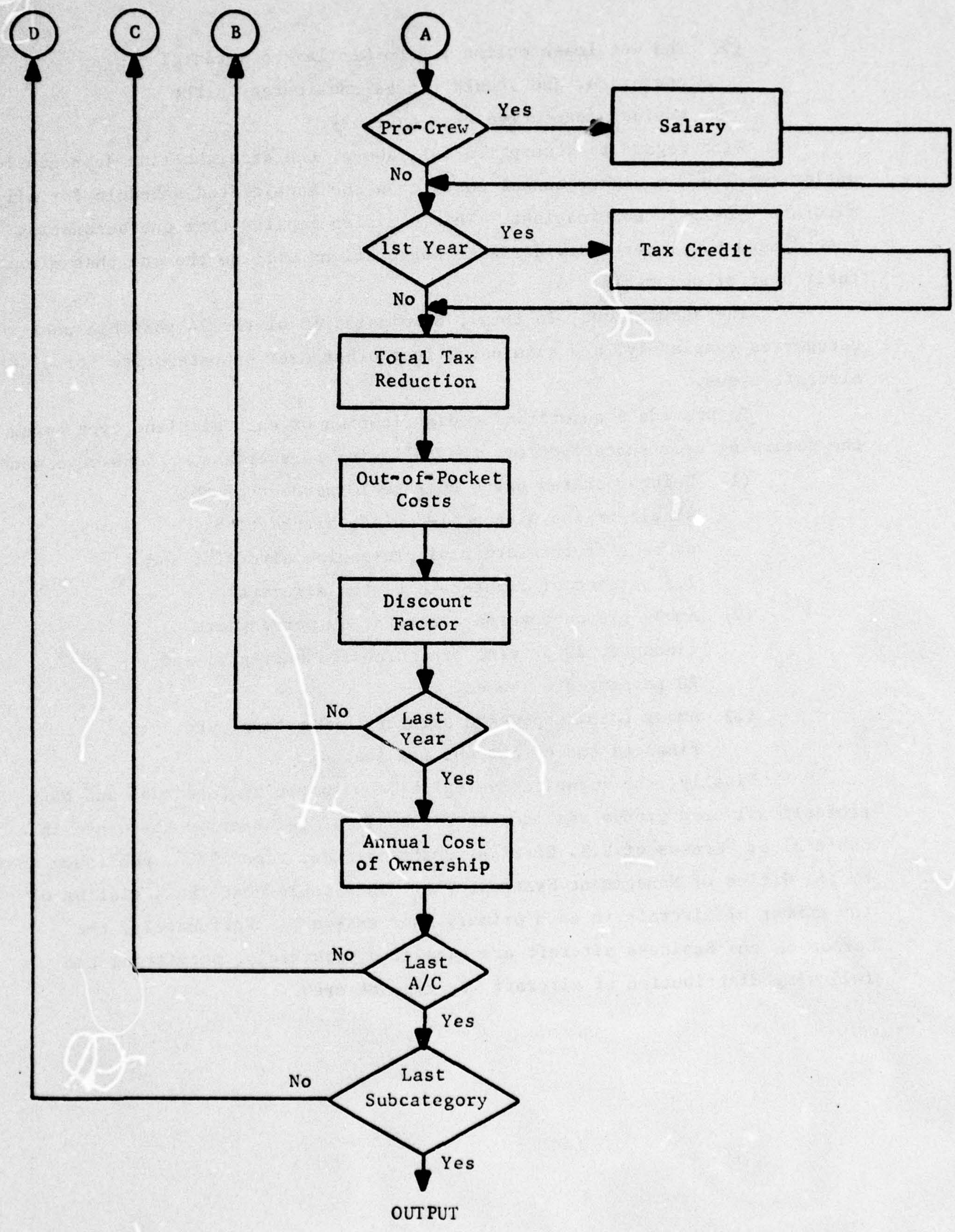

FIGURE 5. (Continued)

(5) The wet lease option is too similar to a rental operation, and should not be considered in the business/executive user category.

With regard to assumption (4), above, the straight-line depreciation option resulted in higher annual costs than the accelerated schedule for all aircraft type/user combinations. This decision implies that the accounting method used by either individuals or corporations will be the one that minimizes their cost of ownership.

The assumptions, in total, eliminated 15 of the 24 possible user subcategories completely, and eliminated four other user subcategories for certain aircraft types.

To provide a quantitative distribution of each airplane type among the remaining user subcategories, the following further assumptions were made:

(1) Unincorporated users operate 10 percent of the single-engine piston, 1-3 place aircraft; 5 percent of the larger single-engine aircraft; and 2.5 percent of light-twin piston aircraft.

(2) Among piston-powered aircraft, 60 percent are financed, 20 percent are purchased outright, and 20 percent are leased.

(3) Among turbine-powered aircraft, 60 percent are financed and 40 percent are leased.

Finally, the quantitative split between the professional and non-professional crew groups was made on the basis of information contained in Table 21 of "Census of U.S. Civil Aircraft-Calendar Year 1972", published by the Office of Management Systems, FAA. This table contains a listing of the number of aircraft in each primary user category. Fortunately, the Corporate and Business aircraft are tabulated separately, permitting the following distribution of aircraft by type of crew.

TABLE 11. BUSINESS/CORPORATE FLEET AS DETERMINED BY PRIMARY USE - 1972.

Aircraft Type	Percentage Distribution Professional Crew	Non-Professional
Piston, Single-Engine	4.98%	95.02%
Piston, Multi-Engine	36.81%	63.19%
Turbo-Prop, Multi-Engine	94.20%	5.80%
Turbojet, Multi-Engine	97.90%	2.10%
Rotary-Wing, Piston	33.00%	67.00%
Rotary-Wing, Turbine	80.33%	19.67%

Table 12 displays the distribution resulting from the foregoing data and assumptions. The number in each element of the matrix is the fraction of the airplane type which is operated by the particular user subcategory. The numbers in each column, therefore, add to unity. To translate these data into the actual number of aircraft, for each user subcategory, the fraction of Table 12 would be multiplied by the number of aircraft, of the particular type, as given in Table 2.

The remaining user subcategories in Table 12 have been designated by Roman numerals which will be used throughout the remainder of this report.

Equivalent Annual Cost. The equivalent Annual Cost obtained from the discounted cash flow analysis for each of the remaining combinations is presented in Table 13, along with the weighted average for each aircraft type based upon the distribution of Table 12. For a given ownership-operator combination, the lease option results in the lowest annual cost, followed by the finance option then the outright purchase option. Of course, in a lease agreement, the lessee does not own anything at the termination of the lease. However, the low purchase price option available at lease termination, would still allow for purchase of the aircraft at a lower net cost than either of the other two finance options. The finance option is better than the outright purchase here, because an internal rate of return on investment of 12 percent

TABLE 12. PROPORTION OF EACH AIRCRAFT TYPE REPRESENTED BY EACH USER SUBCATEGORY

Operator	Crew	Ownership	Method	SUBCATEGORY DESIGNATION	FAA AIRCRAFT TYPE 1	2	3	6	7	8	9	11	12	13
NON-CORPORATE OPERATOR	NON-PROFESSIONAL CREW	LEASE	DRY	I	.020	.010	.005							
			WET											
		FINANCE	ACCEL.	II	.060	.030	.015							
			ST. LINE											
		OWN	ACCEL.	III	.020	.010	.005							
			ST. LINE											
	PROFESSIONAL CREW	LEASE	DRY											
			WET											
		FINANCE	ACCEL.											
			ST. LINE											
		OWN	ACCEL.											
			ST. LINE											
CORPORATE OPERATOR	NON-PROFESSIONAL CREW	LEASE	DRY	IV	.170	.180	.121	.024		.008			.134	.080
			WET											
		FINANCE	ACCEL.	V	.510	.540	.363	.036		.012			.402	.120
			ST. LINE											
		OWN	ACCEL.	VI	.170	.180	.121						.134	
			ST. LINE											
	PROFESSIONAL CREW	LEASE	DRY	VII	.010	.010	.074	.376	.400	.392	.400	.400	.066	.320
			WET											
		FINANCE	ACCEL.	VIII	.030	.030	.222	.564	.600	.588	.600	.600	.198	.480
			ST. LINE											
		OWN	ACCEL.	IX	.010	.010	.074						.066	
			ST. LINE											

TABLE 13. EQUIVALENT ANNUAL COST ($/YR) - BASED ON DCF ANALYSIS

User Subcategory	Aircraft Type 1	2	3	6	7	8	9	11	12	13
I	2,461	3,511	14,248							
II	2,917	4,162	17,038							
III	3,126	4,460	18,398							
IV	1,606	2,292	9,269	30,321		55,369			5,023	9,360
V	2,168	3,093	12,660	35,967		65,678			5,506	12,784
VI	2,472	3,527	14,549						6,279	
VII	21,306	21,992	29,669	55,071	115,576	82,219	158,404	168,939	30,930	36,210
VIII	21,868	22,793	33,060	60,717	132,039	92,528	182,414	193,634	32,356	39,634
IX	22,172	23,227	34,949						33,128	
Weighted Average*	3,176	4,058	20,017	56,974	125,454	87,867	172,810	183,756	14,362	32,894

*Based upon distribution in Table 12.

was assumed, as explained on page 14, whereas the effective interest rate on all aircraft loans is substantially less than 12 percent. If a corporation were not realizing an internal rate of return which was greater than the interest rate charged, then outright purchase would yield a lower equivalent annual cost than the finance option.

Appendix B contains the out-of-pockets costs encountered for each year of aircraft operation, which provide the basis for discounting back to an equivalent annual cost.

Table 14 is a comparison of the Annualized Investment values of the present study with those prepared by ADS, for the year 1972, by the method used in the previous Cost Impact Study.

It appears that, in general, the effect of the addition of crew costs in this analysis tends to offset the tax benefits except for turbine-powered fixed-wing aircraft. For rotary-wing aircraft, the simple ADS calculation greatly underestimates the annualized investment.

Influence Coefficients

Much of the required input data presented in Tables 9 and 10, although based on readily available data and sound judgment, is subject to conjecture. Therefore, influence coefficients were developed to indicate the dependence of annual ownership costs on the values for sales tax, investment tax credit, mortgage interest rate, salaries, and aircraft purchase price.

Table 15 presents the influence coefficients for each individual user subcategory-aircraft type combination for variations in the sales tax rate. The values in the table are given in terms of percent increase in annualized investment per percentage point increase in the sales tax. Thus, a value of 0.41 means a one point increase in sales tax (e.g., from 5 percent to 6 percent) will result in a 0.41 percent increase in the equivalent annual cost for that user/aircraft combination. A negative value indicates that an increase in the sales tax will actually result in a decrease in the equivalent annual cost. This apparent contradiction only appears in the lease option for corporate owners. The reason it has this effect is because the entire sales tax-credit has been passed on to the lessee to claim as a business expense during the first year of operation, but it is being paid back to the lessor over the term of the lease.

TABLE 14. COMPARISON OF ANNUALIZED INVESTMENT COST CENTERS ($/YEAR - 1972 DATA)

Aircraft Type	ADS Method	Current Analysis	Percentage Change from ADS
1. Single-Engine Piston, 1-3 Seat	2,997	3,176	+ 6.0
2. Single-Engine Piston, 4 Place & Over	4,276	4,058	- 5.1
3. Twin-Piston, Under 12,500 lb TOGW	17,639	20,017	+13.5
6. Twin Turboprop, Under 20,000 lb TOGW	70,215	56,974	-18.9
7. Twin Turboprop, Over 20,000 lb TOGW	180,000	125,454	-30.3
8. Twin-Turbojet/Fan, Under 20,000 lb TOGW	95,797	87,867	- 8.3
9. Twin Turbojet/Fan, Over 20,000 lb TOGW	218,750	172,810	-21.0
11. Multi-Turbojet/Fan, Over 20,000 lb TOGW	225,000	183,756	-18.3
12. Rotary Wing, Piston	7,612	14,362	+88.7
13. Rotary Wing, Turbine	16,625	32,894	+97.9

TABLE 15. SALES TAX INFLUENCE COEFFICIENTS FOR INDIVIDUAL SUBCATEGORIES

Bus/Corp User Subcategory	Aircraft Type 1	2	3	6	7	8	9	11	12	13
I	0.41	0.41	0.40							
II	0.79	0.79	0.79							
III	0.80	0.80	0.80							
IV	-0.04	-0.04	-0.06	-0.14		-0.14			-0.06	-0.06
V	0.77	0.77	0.77	0.72		0.72			0.77	0.77
VI	0.79	0.79	0.79						0.79	
VII	0	0	-0.02	-0.08	-0.11	-0.10	-0.12	-0.11	0	-0.02
VIII	0.08	0.10	0.29	0.43	0.57	0.51	0.60	0.59	0.13	0.25
IX	0.09	0.12	0.33						0.15	

$\frac{\Delta \text{ A.I.}}{\Delta \text{ Sales Tax}}$, %/Pt.

TABLE 17. INTEREST RATE INFLUENCE COEFFICIENTS FOR INDIVIDUAL SUBCATEGORIES

Bus/Corp User Subcategory	Aircraft Type 1	2	3	6	7	8	9	11	12	13
I	--	--	--							
II	1.58	1.58	1.58							
III	--	--	--							
IV	--	--	--	--		--			--	--
V	1.61	1.60	1.61	3.34		3.34			1.61	1.61
VI	--	--	--						--	
VII	--	--	--	--	--	--	--	--	--	--
VIII	0.16	0.22	0.62	1.98	2.65	2.37	2.80	2.71	0.27	0.52
IX	--	--	--						--	

$\frac{\Delta \text{ A.I.}}{\Delta \text{ Int. Rate}}$, %/Pt.

TABLE 18. CREW SALARY INFLUENCE COEFFICIENTS FOR INDIVIDUAL SUBCATEGORIES

Bus/Corp User Subcategory	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
I	--	--	--							
II	--	--	--							
III	--	--	--							
IV	--	--	--	--		--			--	--
V	--	--	--	--		--			--	--
VI	--	--	--						--	
VII	0.92	0.90	0.69	0.45	0.23	0.33	0.18	0.21	0.87	0.74
VIII	0.90	0.86	0.62	0.41	0.20	0.29	0.16	0.19	0.83	0.68
IX	0.89	0.85	0.58						0.81	

$\frac{\Delta \text{ A.I.}}{\Delta \text{ Salary}}$, %/%

Table 16 presents similar data on the influence coefficients as a function of investment tax credit. Again the values are based on percentage/point. All values are negative, indicating an increase in the allowable investment tax credit will decrease the equivalent annual cost of ownership. Note that the investment tax credit does not influence user subcategories I, II, and III which represent noncorporate owners; these individuals are not allowed the tax credit.

Table 17 presents similar data as a function of interest rate, in terms of percentage/point. Only the user subcategories pertaining to the finance option are affected.

Table 18 indicates the influence of annual salaries in percentage/percentage. Thus, a value of 0.92 means a 10 percent increase in the total annual salary will result in a 9.2 percent increase in equivalent annual cost.

Table 19 presents values as a function of aircraft price in percentage/percentage. Only those user subcategories which employ professional crews have values different from 1.00.

Table 20 is a list of influence coefficients for the composite business/executive user category. These values were obtained by weighting the individual subcategory values according to the relative frequencies of Table 12.

Cost Sensitivity Models

The basis for determining the sensitivity of variable, fixed, or total cost changes to changes in an individual cost center is the cost structure. Cost structure is defined as the percent distribution of the individual cost centers relative to the total. Thus, the cost sensitivity models for the various aircraft type-user subcategory combinations are formulated by substituting the appropriate values (defined as cost sensitivity coefficients) into the following general cost sensitivity model:

TABLE 16. INVESTMENT TAX CREDIT INFLUENCE COEFFICIENTS FOR INDIVIDUAL SUBCATEGORIES

Bus/Corp User Subcategory	Aircraft Type 1	2	3	6	7	8	9	11	12	13
I	--	--	--							
II	--	--	--							
III	--	--	--							
IV	-2.43	-2.43	-2.48	-2.68		-2.68			-2.44	-2.48
V	-1.81	-1.80	-1.82	-2.26		-2.26			-1.80	-1.82
VI	-1.58	-1.58	-1.58						-1.58	
VII	-0.18	-0.25	-0.79	-1.48	-2.05	-1.81	-2.18	-2.10	-0.32	-0.64
VIII	-0.18	-0.24	-0.70	-1.34	-1.80	-1.60	-1.90	-1.84	-0.31	-0.59
IX	-0.18	-0.24	-0.66						-0.30	

$\frac{\Delta \text{ A.I.}}{\Delta \text{ Inv. Tax Credit}}$, %/Pt.

TABLE 19. PURCHASE PRICE INFLUENCE COEFFICIENTS FOR INDIVIDUAL SUBCATEGORIES

Bus/Corp User Subcategory	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
I	1.00	1.00	1.00							
II	1.00	1.00	1.00							
III	1.00	1.00	1.00							
IV	1.00	1.00	1.00	1.00		1.00			1.00	1.00
V	1.00	1.00	1.00	1.00		1.00			1.00	1.00
VI	1.00	1.00	1.00						1.00	
VII	0.08	0.10	0.31	0.55	0.76	0.67	0.81	0.78	0.13	0.26
VIII	0.10	0.14	0.38	0.59	0.79	0.71	0.84	0.81	0.17	0.32
IX	0.11	0.15	0.42						0.19	

$\frac{\Delta \text{ A.I.}}{\Delta \text{ A/C Price}}$, %/%

TABLE 20. INFLUENCE COEFFICIENTS ON THE ANNUAL COST OF OWNERSHIP

Composite Business/Corporate User Category

	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
$\frac{\Delta A.I.}{\Delta \text{ Sales Tax}}$, %/Pt.	0.45	0.48	0.40	0.24	0.32	0.28	0.34	0.33	0.28	0.17
$\frac{\Delta A.I.}{\Delta \text{ Inv. Tax Crdt.}}$, %/Pt.	-1.14	-1.36	-1.14	-1.44	-1.90	-1.70	-2.00	-1.96	-0.60	-0.70
$\frac{\Delta A.I.}{\Delta \text{ Int. Rate}}$, %/Pt.	0.68	0.76	0.62	1.24	1.68	1.50	1.78	1.72	0.38	0.38
$\frac{\Delta A.I.}{\Delta \text{ Salary}}$, %/%	0.31	0.24	0.38	0.41	0.22	0.30	0.17	0.20	0.62	0.65
$\frac{\Delta A.I.}{\Delta \text{ A/C Price}}$, %/%	0.70	0.75	0.62	0.59	0.78	0.70	0.83	0.80	0.38	0.35

$$\% \text{ Change in Sum of Cost Centers} = \% \text{ Change in Cost Center} \times \frac{\text{Cost Center}}{\text{Sum of Cost Centers}}.$$

It was noted in the previous cost impact study that the cost structures vary with time within a given aircraft type-user subcategory combination. The method used in the previous study, and adhered to in the present program, is to base the practicable cost structure on the latest available year's data. An underlying rationale in all the models is that other cost centers not directly influenced are held constant. Therefore, it is not necessary to construct curves of the cost sensitivity relationships. Since the relationships are linear, all that is needed is to define the slope for each cost sensitivity model, regardless of the size of the increment.

Variable Cost Sensitivity

The data for variable cost ($/hr), hours in service, and number of aircraft in operation which was provided by ADS is reproduced in Table 21. The average annual utilization for each aircraft type can be determined simply by dividing the number of aircraft into the hours in service. Multiplying each variable cost ($/hr) by the average aircraft utilization (hr/yr) results in an annual variable cost figure. These values are also shown in Table 21 and will be useful in constructing total cost sensitivities.

In the previous program, all costs were considered to be before-tax costs. However, since the Annualized Investment, as defined in the present study, represents an after-tax cost, it is necessary to convert all the ADS-supplied cost figures to equivalent after-tax values. Recalling that personal income tax rates of 36 percent for noncorporate owners and 50 percent for corporate owners were used in calculating the Annualized Investment, these same rates were applied to the annual variable and fixed costs for each aircraft type-user subcategory. The user subcategory within business/executive specifies the particular tax rate to be applied. By weighting the resultant values according to the relative percentage of owners within a certain aircraft type as defined in Table 12 (hereafter referred to as the composite business/corporate user category), the after-tax costs in Table 22 are obtained. Similar costs for each of the nine different user subcategories are presented in Appendix C.

TABLE 21. VARIABLE COSTS, NUMBER OF A/C, AND HOUR OF SERVICE

	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
Variable Costs, $/Hr										
Fuel & Oil	4.95	7.37	18.20	34.70	111.90	141.13	184.31	292.88	6.74	12.43
A/F & Av	1.82	3.00	9.50	20.93	91.50	51.05	120.29	121.71	10.49	15.89
Eng	1.36	2.11	9.29	21.59	16.25	42.30	64.29	93.05	3.67	17.46
Total	8.13	12.48	36.99	77.22	219.65	234.48	368.89	507.64	20.90	45.78
Hours Service	340,528	4,045,822	3,363,960	525,048	159,963	305,046	254,745	135,740	87,696	86,846
No. A/C	3,151	22,942	11,640	1,002	213	538	405	220	336	236
Avg Util Hr/Yr	109	176	289	524	751	567	629	617	261	368
Variable Costs, $/Yr										
Fuel & Oil	540	1,297	5,260	18,183	84,037	80,021	115,931	180,707	1,759	4,574
A/F & Av	198	528	2,746	10,967	68,716	28,945	75,662	75,095	2,738	5,848
Eng	148	371	2,685	11,313	12,204	23,984	40,438	57,412	958	6,425
Total	886	2,196	10,691	40,463	164,957	132,950	232,031	313,214	5,455	16,847

TABLE 22. VARIABLE AND FIXED COSTS

(After Tax)

	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
<u>Variable Costs ($/Yr)</u>										
Fuel & Oil	278	666	2,704	9,092	42,018	40,010	57,965	90,354	879	2,287
A/F & Av Maint	102	271	1,411	5,483	34,358	14,473	37,831	37,547	1,369	2,924
Eng Maint	76	191	1,380	5,656	6,102	11,992	20,219	28,706	479	3,212
Total	456	1,128	5,495	20,231	82,478	66,475	116,015	156,607	2,727	8,423
<u>Fixed Costs ($/Yr)</u>										
A.I.	3,176	4,058	20,016	56,972	125,454	87,868	172,810	183,756	14,364	32,896
Hull Insurance	462	578	1,244	4,681	11,250	6,227	12,032	11,250	3,045	5,987
Med & Lia Ins	90	155	181	750	1,800	690	750	1,970	175	330
Hangar & Tie Down	285	323	700	1,416	6,162	4,553	5,030	5,918	312	413
Fed User Charges	13	39	75	204	708	307	665	706	15	69
Misc Fixed Costs	48	63	105	1,184	3,200	2,186	4,591	4,640	61	102
Total	4,074	5,216	22,321	65,207	148,574	101,831	195,878	208,240	17,972	39,797
Grand Total	4,530	6,344	27,816	85,438	231,052	168,306	311,893	364,847	20,699	48,220

The variable cost structure for a given aircraft type is the same for all user subcategories, and thus the composite business/executive category also. Although the after-tax values for variable cost will differ between corporate and noncorporate user subcategories because of the different tax rates, the relative percentages of total variable cost will remain the same. Aircraft type determines the variable cost structure. Table 23 contains the variable cost structure for each aircraft type.

In order to determine the resultant change in variable cost due to a change in one of the variable cost centers, it is best to convert the percentage values of Table 23 to decimal fractions. For example, if fuel and oil costs increased by 6 percent, the increase in variable cost for aircraft type 1 would be

$$\% \; \Delta\text{Variable Cost} = (.6096)\;(6\%) = 3.66\%.$$

Fixed Cost Sensitivity

The fixed cost structure for a given aircraft type will vary among user subcategories. This is due to the different Annualized Investment values obtained for each user subcategory. Table 23 contains the fixed cost structure for the composite business/corporate user category. Fixed cost structures for the individual user subcategories can be found in Appendix C. The fixed cost sensitivity coefficients should also be converted to decimal fractions. whereupon they can be used exactly as the variable sensitivity coefficients to determine percentage changes in total fixed cost due to a change in an individual fixed cost center.

The total annual cost of an aircraft can be expressed as the sum of the annual variable cost plus the annual fixed cost. Total cost structure for a given aircraft type also varies among user subcategories. Table 23 presents the total cost structure for the composite business/corporate user category. Total cost structures for individual user subcategories can be found in Appendix C.

TABLE 23. COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE: COMPOSITE BUS/CORP

AIRCRAFT TYPE

	1			2			3		
Variable Cost	$/Yr	% VC	% TC	$/Yr	% VC	% TC	$/Yr	% VC	% TC
Fuel & Oil	278	60.96	6.14	666	59.04	10.50	2,704	49.21	9.72
A/F & AV	102	22.37	2.25	271	24.02	4.27	1,411	25.68	5.07
Eng	76	16.67	1.68	191	16.93	3.01	1,380	25.11	4.96
Total	456		10.07	1,128		17.78	5,495		19.75
Fixed Costs	$/Yr	% FC	% TC	$/Yr	% FC	% TC	$/Yr	% FC	% TC
A.I.	3,176	77.96	70.11	4,058	77.80	63.96	20,016	89.67	71.96
Hull Ins	462	11.34	10.20	578	11.08	9.11	1,244	5.57	4.47
Med & Liab Ins	90	2.21	1.99	155	2.97	2.44	181	0.81	0.65
Hangar, Etc.	285	7.00	6.30	323	6.19	5.09	700	3.14	2.52
Fed Fee	13	0.32	0.29	39	0.75	0.61	75	0.34	0.27
Misc	48	1.17	1.06	63	1.21	0.99	105	0.47	0.38
Total	4,074		89.93	5,216		82.22	22,321		80.25
Grand Total	4,530			6,344			27,816		

TABLE 23. (Continued)

	6			7			8		
Variable Cost	$/Yr	% VC	% TC	$/Yr	% VC	% TC	$/Yr	% VC	% TC
Fuel & Oil	9,092	44.94	10.64	42,018	50.94	18.18	40,010	60.19	23.77
A/F & AV	5,483	27.10	6.42	34,358	41.66	14.87	14,473	21.77	8.60
Eng	5,656	27.96	6.62	6,102	7.40	2.64	11,992	18.04	7.13
Total	20,231		23.68	82,478		35.69	66,475		39.50
Fixed Costs	$/Yr	% FC	% TC	$/Yr	% FC	% TC	$/Yr	% FC	% TC
A.I.	56,972	87.37	66.68	125,454	84.44	54.30	87,868	86.29	52.20
Hull Ins	4,681	7.18	5.48	11,250	7.57	4.87	6,227	6.12	3.70
Med & Liab Ins	750	1.15	0.88	1,800	1.21	0.78	690	0.68	0.41
Hangar, Etc.	1,416	2.17	1.66	6,162	4.15	2.67	4,553	4.47	2.71
Fed Fee	204	0.31	0.24	708	0.48	0.31	307	0.30	0.18
Misc	1,184	1.82	1.39	3,200	2.15	1.38	2,186	2.15	1.30
Total	65,207		76.32	148,574		64.31	101,831		60.50
Grand Total	85,438			231,052			168,306		

TABLE 23. (Continued)

	9			11			12		
Variable Cost	$/Yr	% VC	% TC	$/Yr	% VC	% TC	$/Yr	% VC	% TC
Fuel & Oil	57,965	49.96	18.58	90,354	57.69	24.76	879	32.25	4.25
A/F & AV	37,831	32.61	12.13	37,547	23.98	10.29	1,369	50.19	6.61
Eng	20,219	17.43	6.48	28,706	18.33	7.87	479	17.56	2.31
Total	116,015		37.19	156,607		42.92	2,727		13.17
Fixed Costs	$/Yr	% FC	% TC	$/Yr	% FC	% TC	$/Yr	% FC	% TC
A.I.	172,810	88.22	55.41	183,756	88.24	50.36	14,364	79.92	69.39
Hull Ins	12,032	6.14	3.86	11,250	5.40	3.08	3,045	16.94	14.71
Med & Liab Ins	750	0.38	0.24	1,970	0.95	0.54	175	0.97	0.84
Hangar, Etc.	5,030	2.57	1.61	5,918	2.84	1.62	312	1.74	1.51
Fed Fee	665	0.34	0.21	706	0.34	0.19	15	0.08	0.07
Misc	4,591	2.34	1.47	4,640	2.23	1.27	61	0.34	0.29
Total	195,878		62.81	208,240		57.08	17,972		86.83
Grand Total	311,893			364,847			20,699		

TABLE 23. (Continued)

	13								
Variable Cost	$/Yr	% VC	% TC	$/Yr	% VC	% TC	$/Yr	% VC	% TC
Fuel & Oil	2,287	27.15	4.74						
A/F & AV	2,924	34.71	6.06						
Eng	3,212	38.14	6.66						
Total	8,423		17.47						
Fixed Costs	$/Yr	% FC	% TC	$/Yr	% FC	% TC	$/Yr	% FC	% TC
A.I.	32,896	82.66	68.22						
Hull Ins	5,987	15.04	12.42						
Med & Liab Ins	330	0.83	0.68						
Hangar, Etc.	413	1.04	0.86						
Fed Fee	69	0.17	0.14						
Misc	102	0.26	0.21						
Total	39,797		82.53						
Grand Total	48,220								

Sample Calculation

At this point, the use of the Annualized Investment Influence Coefficients together with the Cost Sensitivity Coefficients, will be illustrated by two examples.

It is hypothesized that the investment tax credit is to be increased from 7 to 12 percent. We will establish the resulting changes in fixed and total costs for a particular aircraft type and user subcategory, and also for the composite user category for a given aircraft type.

Specific Segment

For illustration, the specific case will be the combination of Aircraft type 9 and User Subcategory VIII; that is, a twin-engine turbojet/fan, over 20,000 lb TOGW, operated by a professional crew for a corporation which is acquiring the aircraft through a mortgage loan and is using the accelerated depreciation schedule for accounting purposes.

The total investment tax credit change is five points, and from Table 16,

$$\frac{\Delta \text{ A.I.}}{\Delta \text{ Inv. Tax Credit}} = -1.90\%/\text{Pt.}$$

so, Δ A.I. = 5 (-1.90) = -9.50%.

In other words, the 5 point change in investment tax credit causes a reduction in the Annualized Investment of 9.5 percent. This is then translated into a fixed cost increment by the relationship,

$$\% \Delta FC = \% \Delta \text{ A.I.} \times \frac{\text{A.I.}}{FC} \quad . \qquad (1)$$

From Appendix C, for Aircraft Type 9, and User Subcategory VIII, the Annualized Investment is seen to constitute 88.77 percent of the fixed costs. Converting this to a decimal ratio (.8877), and substituting into Equation (1),

$$\% \Delta TC = -9.5 \ (.5674) = -5.39.$$

So, for this particular aircraft type and user subcategory, a 5 point increase in the investment tax credit could be expected to reduce the total costs of ownership and operation by 5.39 percent.

Composite User Category

According to Table 11, airplanes from Type 9 are also operated by User Subcategory VII, which differs from the previous case in that the aircraft is leased instead of financed. The combined sensitivity for both user subcategories may be computed as follows.

From Table 20,

$$\frac{\Delta \text{ A.I.}}{\Delta \text{ Inv. Tax Credit}} = -2.00 \quad .$$

So, the change in Annualized Investment is,

$$\Delta \text{ A.I.} = 5\ (-2.00) - -10\%.$$

The Annualized Investment constitutes 88.22 percent of the fixed costs, and 55.41 percent of total cost for the composite user category, according to Table 23. Converting to a decimal factor and using Equation (1),

$$\%\ \Delta FC = (-10.0)\ (.8822) = -8.82.$$

Similarly, for the effect on total cost,

$$\%\ \Delta TC = (-10.0)\ (.5541) = -5.54.$$

CHAPTER 2: COST-IMPACT RELATIONSHIPS

Assumptions and Limitations

The purpose of this section is to specify a set of relationships which reflect the behavioral response of business/corporate aircraft owners (and potential owners) to those factors affecting the cost of aircraft ownership and operation. Behavioral response is measured in terms of changes in the following two basic activities:

(1) The number of aircraft in operation (fleet size)

(2) The number of hours flown (fleet utilization).

The set of variables considered in this analysis is consistent with the variables identified for the business/corporate user category of the previous cost-impact study. A major assumption adopted for the regression analysis is that fixed cost is associated with ownership and hence becomes the primary cost factor influencing the activity measure for number of aircraft, whereas variable cost, which is only incurred during operation, is the primary determinant for fleet utilization. This assumption is the basis for constructing pooled regression relationships across different aircraft types. It will be valid only to the extent that fixed and variable cost do explain the differences in activity between aircraft types.

Two potential problem areas which may arise in the cost impact analysis are related to collinearity and aggregation. The collinearity problem can be illustrated by the separate use of variable cost and fixed cost in the hours and aircraft activity relationships. These two cost variables are quite highly correlated, confirming that high variable costs are associated with aircraft having high fixed costs. A possibility therefore exists that the variable cost effect estimated in the hours activity relationship does not provide an accurate reflection of the effect of variable cost on activity. The relationship actually estimated could result from the following.

(1) Variable cost is positively correlated with fixed cost

(2) Fixed cost is negatively correlated with the number of aircraft

(3) Number of aircraft is positively correlated with the hours flown.

Variable cost may thus not have an independent effect on hours flown and the relationship actually estimated may reflect the influence of other factors.

The second problem area, as previously noted, is related to aggregation. Again the nature of this consideration may best be discussed through the use of an example. One of the variables used to explain activity variation for the corporate category is gross corporate profits for all industries. At an aggregate level this variable may prove to be of only minor significance. At the micro level, however, if activity measures were available for individual corporations, corporate profits might prove to be of more significance.

A further illustration of a problem associated with aggregation is obtained from a consideration of fixed cost. The largest component of fixed cost is attributable to costs associated with principal and interest. The real cost of this component to an individual will vary, however, depending upon source of income, the individual's marginal tax bracket, equity in the aircraft. These considerations can in turn lead to questions of whether only monetary costs should be considered or whether the concept of opportunity cost should be introduced. The problem here is that as a study becomes more micro oriented the data requirements and cost increase substantially and special attention has to be given to the specific characteristics of the user in question. The purpose of this analysis, however, is to work with those variables which reflect a common condition confronting all users within a given category.

The two limitations just discussed are by no means unique to this particular undertaking. Collinearity and aggregation are factors which warrant consideration in any multivariate statistical investigation.

Data Analysis Technique

The analytical technique used to estimate the relationship between the activity measures (dependent variables) and a hypothesized set of causal variables (independent variables) was regression analysis. In all user categories, the relationships were estimated in the "log linear form". That is,

$$\ln Y = a + b_1 \ln X_1 + b_2 \ln X_2 + u$$

where

Y = an activity measure

X_1 = the first hypothesized independent variable

X_2 = a second hypothesized independent variable, and

"ln" denotes the variable has been converted to its natural logarithm

a, b_1, b_2 are parameters to be estimated from the regression

u = random error terms from the analysis.

In terms of the original variables, the log linear form is equivalent to the following expression.

$$Y = AX_1^{b_1} X_2^{b_2}$$

where

$A = e^a$; $e = 2.7183$.

In the previous cost impact study, the decision was made to combine both time series and cross-section samples to estimate the parameters in a single equation. Here cross-section data refers to observations at an instant of time on different aircraft types. In a cross-section sample, corporate profits, consumer income, and other variables are held constant. Thus, in principle, if a single independent variable can be identified which explains the difference in activity levels between aircraft types, it is possible to pool the cross-section data with the time-series data. Within the previous cost impact study, fixed cost and variable cost were assumed to play this role in the two regression equations for activity levels. This pooling technique expands the available data base, but at the expense of being able to precisely predict the behavior of individual aircraft types.

Two sets of regression relationships were developed during this program. One is consistent with the pooled model of the previous study. Two more years of data (1971 and 1972) have been added. Another set of relationships was developed for each individual aircraft type, that is, without pooling.

During the previous study, data were collected for the year 1965 through 1970. However, since one of the variables contained in the regression model is a lagged variable, it was possible to use only five temporal data points. This was considered an inadequate data base for a time-series study. Therefore, the decision was made to pool the time-series data with cross-sectional data representative of eight different aircraft types. In effect, the pooling of time-series and cross-sectional data provided for a statistical analysis with (40-k)* degrees of freedom. Two additional years of data were added to this combined data base, providing (56-k) degrees of freedom, or an increase of 16 degrees of freedom.

Although seven data points in a time-series analysis is still less than normally desired, another set of regression relationships was developed for each individual aircraft type. The decision to perform this type of analysis was based on the gross inaccuracies obtained from the pooled relationships when attempting to estimate activity measures for individual aircraft types.

In all instances, when variables expressed in dollars are included in a time-series analysis, the variables are converted to 1970 dollar equivalents prior to an estimate of the regression equations.

Cost Elasticity

One of the major items of interest to be derived from the cost impact relationships are estimates of cost elasticities. Cost elasticity is a mesure of the percentage change in an activity measure that results

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* k is the number of parameters estimated for the model.

from a percentage change in one of the cost variables. Since activity measures are a function of other variables in addition to cost, it is assumed that only cost varies when elasticities are calculated. The purpose of elasticity estimates is to provide an indication of sensitivity of activity measures to variations in cost.* In the arithmetic derivation of elasticities, the numbers that result have bounds of zero and minus infinity. Since negative numbers are often confusing to work with, it is conventional to deal with these numbers in absolute value. Thus, elasticities are often dealt with as numbers varying between zero and plus infinity. Elasticity values between zero and one are classified as inelastic; indicating that the percentage change in the activity will be less than the percentage change in cost which produced the activity variation. Elasticity values in excess of one are referred to as elastic; indicating the percentage change in the activity will be in excess of the percentage change in cost which produced the variation.

Algebraically, elasticity may be considered as follows where the Δ notation is used to indicate change

$$\text{Elasticity} = \frac{\%\,\Delta\,\text{Activity}}{\%\,\Delta\,\text{Cost}} = \left(\frac{\Delta\,\text{Activity}}{\text{Activity}} \bigg/ \frac{\Delta\,\text{Cost}}{\text{Cost}} \right)$$

Equivalently, elasticity may be represented as

$$\frac{\Delta A}{A} \bigg/ \frac{\Delta C}{C} = \frac{\Delta A}{\Delta C} \cdot \frac{C}{A}$$

where $\Delta A / \Delta C$ may be interpreted as the derivative of the activity relationship with respect to the cost variable.

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* Since elasticity is defined at a point, the validity of its use as a multiplier is restricted to small variations in cost. The magnitude of cost impact from large cost variations must be calculated directly from the regression equations.

A particular feature resulting from the form of the activity relationships used in the study is that cost elasticities assume the same value as the regression coefficients. The following is presented as a mathematical demonstration of this fact.

The equations estimated are of the form

$$\ln A = k + b_1 \ln X + b_2 \ln C \quad ,$$

where ln denotes the natural logarithm.

The logarithmic relationship is equivalent to the relationship

$$A = KX^{b_1} C^{b_2} \quad ,$$

where $K = e^k$; $e = 2.7183$.

From the above expression and the definition of elasticity, elasticity is calculated as

$$\frac{\partial A}{\partial C} \cdot \frac{C}{A} = b_2 KX^{b_1} C^{(b_2 - 1)} \cdot \frac{C}{A} \quad ,$$

and this expression can be reduced to the point where

$$\frac{\partial A}{\partial C} \cdot \frac{C}{A} = b_2 \quad .$$

Thus, the regression coefficients from the variables expressed as logarithms provides estimates for elasticities.

Regression Equations

In this section the two sets of behavioral equations developed for the business/corporate user category are discussed. In each of the subsections (one for each regression model) the variables included in the relationship are discussed. The verbal discussion is followed by the parameter estimates obtained from regression analysis. In each isntance the regression analysis presentation includes statistics referred to as $\bar{R}^2$ and t-statistics. Their explanations are as follows:

(1) $\bar{R}^2$ is the coefficient of determination. This measure presents the ratio of the total amount of variation in the dependent variable of the regression which is explained by the independent variables included in the regression. For example, if a regression is performed with the number of aircraft as the dependent variable and the price of aircraft as the independent variable and $\bar{R}^2$ is reported as .80, the implication is that 80 percent of the variation in aircraft numbers is explained by variations in aircraft price. The bar (-) is included with the statistic as an indicator that an adjustment has been made for the number of degrees of freedom.

(2) The t-statistic is used as a test of the hypothesis that the coefficient of the variable in question is equal to zero. For example, suppose a regression of the following form was conducted

$$Y = a + bx + e,$$

and an estimate of 2.03 was obtained for b. A t-statistic for b could be used as a test of the hypothesis that 2.03 is not statistically significant, i.e., that variations in x are not important in explaining variations in Y. An algebraic equivalent of "not important" is that b is equal to zero. The values for the t-statistic have the same sign as the regression coefficient they are associated with. The absolute value of the t-statistic is interpreted such that a large value implies the variable is statistically important while a small value implies the variable is not statistically significant. The interpretation of large and small varies somewhat depending upon the number of observations on which the regression is based, the number of variables included as independent variables, and the prior beliefs one has about the appropriate sign for the coefficient. For a regression with 25 observations, 3 independent variables, and a specification that the coefficient should be positive, the cut-off between a large and small t-statistic is approximately 1.72. In this study most values beyond 2.00 can be considered as significant.

An additional reminder is in order that all variables used in the regression are expressed in terms of their natural (base e) logarithms.

Pooled Model. The final form of the two equations estimated for this model are as follows.

Number of Aircraft

$$\ln N = \underset{(-2.82)}{-4.244} + \underset{(10.27)}{0.599} \ln H + \underset{(9.75)}{1.228} \ln (PRD/FC)$$

$$+ \underset{(1.06)}{0.363} \ln PRF + \underset{(5.27)}{0.233} \ln (N-1)$$

$$\bar{R}^2 = .98$$

Number of Hours

$$\ln H = \underset{(.57)}{1.608} + \underset{(2.36)}{1.819} \ln ECH - \underset{(-5.88)}{0.567} \ln VC$$

$$\bar{R}^2 = .43$$

Both equations are based on 56 observations. The ln designation is used to indicate the variable expressed in terms of its natural logarithm. The numbers in parentheses below the regression coefficients are the t-statistics. The variable definitions are as follows:

N = the number of aircraft. For the business and corporate category aircraft types 1, 2, 3, 6, 7, 8, 9, and 11 (as described in Table 1) were included in the analysis

H = the number of hours flown by aircraft type, expressed in 1000's of hours

PRD = the productivity of the aircraft by type, expressed in terms of seat miles per hour

FC = the annual fixed cost by aircraft type, expressed as 1000's of 1970 dollars

PRF = corporate profits (before tax) and inventory valuation adjustment, expressed in billions of 1970 dollars

N-1 = the number of aircraft, by type, in the previous year

ECH = average compensation per hour for managers, officials, professional, and technical employees, expressed in 1970 dollars

VC = the variable cost per hour for aircraft by type, expressed in 1970 dollars.

The rationale for the variables included in the hours equation is based upon the opportunity cost of executive time and productivity. As the price of executive time increases, it should be anticipated that business enterprises will look for methods to increase executive efficiency. One such method is the use of aircraft for transportation. Therefore, as the price of executive time increases, the number of hours flown in corporate aviation should increase. On the negative side, the cost of operating an aircraft per hour should work as a deterrent to the use of executive aviation.

The variables in the aircraft equation are rationalized as follows. As the desired number of hours to be flown increases it may logically be anticipated that the number of aircraft in the corporate fleet will increase. By substituting for lnH from the hours equation, it may be noted that the number of aircraft are implicitly dependent upon the executive cost per hour (ECH) and the variable cost of operating the aircraft. It should be noted that the implied chain of causality assumed in this formulation is from the number of flight hours desired to the stock of aircraft in this user category. Since N expresses the number of aircraft by type, the variable expressed as productivity divided by fixed cost is intended to be a reflection of benefit per unit of fixed expenditure. As anticipated, this variable has a positive effect and is an important determinant for the number of aircraft. It should also be noted that this formulation (i.e., PRD/FC) results in a negative relationship between fixed cost and the number of aircraft. Applying a rule of logarithms the expression

$$1.228 \ln (PRD/FC)$$

may be equivalently stated as

$$1.228 \ln PRD = 1.228 \ln FC.$$

The remaining two variables are profit (PRF) and the lagged dependent variable (N-1).

The rationale for the inclusion of profit as an independent variable seems obvious; however, the low t-value warrants some consideration. The profit variable is for all industries and therefore the effect of aggregation is probably to desensitize the data to the effects of this variable.

The inclusion of the lagged value of the dependent variable in the estimated equation results from distributed lag specification often associated with the investment behavior of the firm (see, for example, D. W. Jorgenson and C. D. Siebert, "Theories of Corporate Investment Behavior", American Economic Review, Sept. 1968, 58, pages 681-712).

All the data needed to construct these relationships are presented in Table 24.

Time-Series Model. Regression coefficients were determined for the same set of relationships applied to each aircraft type individually. Tables 25 and 26 present the values for the coefficients which correspond to the following equation.

Number of Aircraft

$$\ln N = a_o + a_1 \ln H + a_2 \ln (PRD/FC)$$
$$+ a_3 \ln PRF + a_4 \ln(N-1)$$

Number of Hours

$$\ln H = b_o + b_1 \ln ECH + b_2 \ln VC \quad .$$

Only the coefficients of independent variables which have any significance at all in explaining the dependent variables are identified in the tables. At the 5 percent significance level, the models hypothesized for number

TABLE 24. DATA REQUIRED FOR REGRESSION ANALYSIS

Year	N	H, hours	PRD 5-Mi/Hr	FC '70 $/Yr	PRF x 10^{-6}, '70 $	N-1	ECH '70 $/Hr	VC '70 $/Hr	A/C Type
1966	1,565	138,940	234	4,330	99,970	863	27.81	6.91	1
	16,038	2,623,560	512	5,890		13,379		11.12	2
	8,255	2,631,670	1,320	23,720		7,286		33.16	3
	52	15,360	2,500	75,080		28		71.32	6
	214	228,840	4,000	205,070		232		191.33	7
	212	93,160	4,064	116,410		42		216.57	8
	81	31,290	8,250	164,850		31		315.21	9
	103	63,410	7,605	251,370		1		430.72	11
1967	1,610	143,050		4,330	92,360		29.42	6.83	
	17,312	2,446,430		6,100				10.74	
	8,630	2,028,730		24,720				33.48	
	371	119,340		72,810				69.66	
	232	149,750		208,760				191.11	
	251	107,710		143,890				207.95	
	163	48,550		241,970				311.47	
	86	35,400		255,990				426.67	
1968	1,678	377,640		4,630	96,880		30.25	6.81	
	18,568	2,173,810		6,140				10.56	
	9,238	2,013,690		24,250				34.06	
	578	188,200		71,740				68.29	
	238	137,540		203,130				192.87	
	324	141,220		138,030				208.69	
	242	81,430		252,970				328.07	
	110	41,160		258,300				435.07	
1969	1,109	189,140		4,360	89,540		35.94	7.04	
	12,973	2,302,550		6,110				10.52	
	8,898	2,137,530		22,990				35.19	
	779	256,420		76,420				68.50	
	212	125,900		208,020				189.45	
	357	167,740		138,760				203.82	
	351	108,130		249,550				318.04	
	164	49,330		258,420				430.16	

TABLE 24. (Continued)

Year	N	H, hours	PRD 5-Mi/Hr	FC '70 $/Yr	PRF x 10^{-6}, '70 $	N-1	ECH '70 $/Hr	VC '70 $/Hr	A/C Type
1970	2,548	275,370		4,270	74,300		40.88	7.37	
	19,470	3,343,730		5,970				10.92	
	9,688	2,799,390		22,480				34.01	
	752	393,530		82,370				71.00	
	216	162,140		211,670				198.52	
	406	230,630		133,130				210.71	
	318	201,310		253,640				325.34	
	175	77,990		276,070				454.53	
1971	2,619	283,049		4,309	75,240		43.85	7.43	
	20,013	3,529,437		6,050				10.96	
	9,957	2,877,413		22,310				33.84	
	772	404,494		80,966				70.66	
	222	166,657		214,960				196.03	
	418	237,057		130,475				208.46	
	329	206,925		251,033				318.41	
	180	80,162		266,179				451.66	
1972	3,151	340,528		* 4,389	86,990		46.66	7.52	
	22,942	4,045,822		6,072				11.55	
	11,640	3,363,960		20,559				34.23	
	1,002	525,048		80,218				71.46	
	213	159,963		209,363				203.26	
	538	305,046		114,494				216.99	
	405	254,745		245,125				341.37	
	220	135,740		253,623				469.77	

* Based on ADS's A.I. Values.

TABLE 25. COEFFICIENTS FOR THE NUMBER OF AIRCRAFT REGRESSION EQUATION--TIME SERIES MODEL

Aircraft Type	A_0	A_1	A_2	A_3	A_4	$\bar{R}^2$
1	16.33 (3.28)	--	--	-1.96 (-1.76)	--	0.38
2	5.22 (2.93)	0.575 (2.57)	--	--	--	0.57
3	2.54 (1.67)	--	1.63 (4.33)	--	--	0.79
6	-10.61 (-3.17)	0.916 (22.14)	3.44 (3.72)	--	--	0.99
7	5.78 (11.10)	-0.075 ((-.73)	--	--	--	0.10
8	-0.0796 (-0.75)	0.874 (154.24)	-0.471 (-25.09)	0.683 (32.93)	--	0.99
9	-3.65 (-1.62)	--	--	1.207 (2.68)	0.730 (12.62)	0.98
11	2.189 (3.55)	0.590 (3.97)	--	--	0.0761 (2.08)	0.85

TABLE 26. COEFFICIENTS FOR THE NUMBER OF HOURS REGRESSION EQUATION--TIME SERIES MODEL

Aircraft Type	b_o	b_1	b_2	$\bar{R}^2$
1	1.233 (0.49)	1.180 (1.69)	--	.36
2	-4.084 (-1.91)	0.667 (4.35)	4.041 (4.10)	.95
3	24.192 (2.62)	0.933 (3.81)	-5.587 (-2.06)	.79
6	121.996 (2.70)	6.010 (6.03)	-32.532 (-2.97)	.90
7	5.660 (3.96)	-0.165 (-0.41)	--	.03
8	-2.244 (-3.34)	2.062 (11.00)	--	.96
9	-8.553 (-5.40)	3.694 (8.35)	--	.93
11	-66.816 (-4.86)	--	11.647 (5.16)	.84

of aircraft is applicable to aircraft types 2, 3, 6, 8, 9, and 11. Furthermore, the form of the relationship for each of these aircraft types, as determined by the independent variables appearing in the regression equation, differs between aircraft types. The procedure followed here was to include in the regression equation only those variables which had significant regression coefficients. In the case of aircraft categories 1 and 7, none of the variables considered was significant. Thus, one can expect that a single model obtained from pooled data including all aircraft types would not produce good results when applied to those aircraft categories which do not fit the model.

Other potential difficulties can be seen by observing the somewhat spotty appearances of Tables 25 and 26. There are no readily discernable patterns relating the significant variables in the equations for different aircraft types. Also, the contentions that fixed cost is an important variable for predicting the number of aircraft and that variable cost is important for number of hours is not supported by any consistent patterns in Tables 25 and 26.

Since the individual regression models corresponding to the turbine-powered aircraft included the better fitting equations, these aircraft categories were pooled and a single model for turbine aircraft was obtained. To attempt to accomplish pooling by including just those aircraft categories for which the individual equations are good would amount to overreacting to the data. These data, as any data obtained from uncontrolled sources, contain both systematic and random biases and the modeler needs to exercise care and restraint to avoid incorporating these biases into a model. There do not appear to be any justifications for trying to improve the regression models given here by seeking different regression functions that use the existing data.

Summary of Regression Results

Arguments were presented in the previous cost impact study that because the data pooling technique was used in the regression analysis, a relatively wide range of ownership and operating cost is covered by each regression equation. It may be true that a wide range of data were used to

generate the regression equations, but the worth of this technique can only be assessed by comparing estimated activity measures with actual reported data. Furthermore, the utility of data pooling is a function of how regression relationships will ultimately be used. Thus, for example, if interest is to be centered upon the entire business/corporate aircraft fleet as a whole, the data pooling technique should provide a more valid estimate of activity measures. However, if the activity measures for each individual aircraft type are desired, pooling of cross-sectional (i.e., across aircraft types) and time-series data may provide erroneous results.

Tables 27 and 28 present a comparison between the estimated values for number of aircraft in operation and hours flown during 1972 and the actual recorded data for 1972 which comprises some of the data base used in determining the regression relationship. The first table is based upon the pooled regression model, the second upon the individual time-series model.

The data within these tables indicate that the pooled regression model provides a fairly good representation of the number of aircraft within each type; however, the estimated annual utilizations for 1972 are quite different from the actual values, especially for aircraft types 1, 2, and 3. The individual time-series models provide good results on both number of aircraft and hours of utilization.

Although the derived regression relationships for individual aircraft types fit the actual data well, the variation in the significant terms which appear in each equation and the variability of the algebraic signs of the coefficients for those variables suggests that neither the number of aircraft nor the annual utilization can be adequately explained with a single regression model. It is possible that a nonbusiness-like approach may be used by many companies to justify the purchase of a business aircraft. That is, the owner of a small company may wish to obtain an aircraft for reasons not completely related to business utility or productivity. Larger companies, however, which may be expected to purchase mor expensive aircraft, would undoubtedly base their purchase decision or utilization rate on sound financial principles. This is probably why the regression models for the turbine-engine powered aircraft proved to be more significant than for the piston aircraft.

TABLE 27. POOLED REGRESSION MODEL

Aircraft Type	1972 Fleet Size Actual	1972 Fleet Size Estimated	1972 Utilization Actual	1972 Utilization Estimated
Composit	40,111	42,583	9,130,852	5,178,993
1	3,151	1,971	340,528	1,726,250
2	22,942	24,479	4,045,822	1,353,428
3	11,640	13,328	3,363,960	730,988
6	1,002	994	525,048	481,577
7	213	200	159,963	266,228
8	538	730	305,046	256,542
9	405	581	254,745	198,418
11	220	300	135,740	165,562

TABLE 28. INDIVIDUAL TIME SERIES REGRESSION MODEL

Aircraft Type	1972 Fleet Size Actual	1972 Fleet Size Estimated	1972 Utilization Actual	1972 Utilization Estimated
1	3,151	1,953	340,528	319,772
2	22,942	21,930	4,045,822	4,299,532
3	11,640	11,206	3,363,960	3,096,323
6	1,002	1,052	525,048	496,786
7	213	221	159,963	152,311
8	538	538	305,046	292,959
9	405	392	254,745	282,203
11	220	240	135,740	126,365

In order to test this logic of a more rational approach to obtaining and operating expensive aircraft, another pooled model was constructed for turbine-powered aircraft only. The resulting relationships were as follows.

Number of Aircraft

$$\ln N = \underset{(-1.94)}{-3.59} + \underset{(11.53)}{0.732} \ln H + \underset{(4.93)}{0.751} \ln \frac{PRD}{FC}$$

$$+ \underset{(2.93)}{1.20} \ln (N-1) + \underset{(1.48)}{0.551} \ln PRF$$

$$\bar{R}^2 = 0.92 \quad .$$

Number of Hours

$$\ln H = \underset{(-0.63)}{-1.158} + \underset{(5.26)}{2.478} \ln ECH - \underset{(-3.68)}{0.535} \ln VC$$

$$\bar{R}^2 = 0.56 \quad .$$

A comparison between estimated and actual 1972 data is presented in Table 29. This model is somewhat better than the one obtained by pooling all aircraft types.

In summary, the mechanics of business/corporate aircraft ownership and operation is an extremely complex system. It appears to be impossible to derive a single regression model that will adequately explain the behavioral activity peculiar to each aircraft type. Activity measures of aircraft in operation and hours flown seem to be mostly dependent upon qualitative factors with respect to the pison-powered aircraft. The regression relationships derived for turbine-powered aircraft can be applied to forecasting with a higher degree of confidence.

TABLE 29. POOLED TURBINE-POWERED AIRCRAFT MODEL

Aircraft Type	1972 Fleet Size		1972 Utilization	
	Actual	Estimated	Actual	Estimated
6	1,002	931	525,048	437,329
7	213	233	159,963	249,991
8	538	641	305,046	241,400
9	405	524	254,745	189,433
11	220	282	135,740	159,688

CHAPTER 3: CORRELATION OF AIRCRAFT AND BUSINESS CHARACTERISTICS

INTRODUCTION

The objective of this task was to identify and classify those aircraft which are operated primarily for business purposes according to the characteristics of the companies and industries in which they are used. If the use of corporate aircraft could be shown to correlate with outstanding financial performance, this information would be useful to the FAA in determining characteristics of corporate aircraft operation.

Data Base

Of about 36,000 aircraft within the business fleet, approximately 9,000 can be classified according to the Standard Industrial Classification (SIC) code; 1,341 of these are operated by companies included in the "Fortune 1000" industrial companies (by sales). Aviation Data Service maintains a complete file on the "Fortune 1000" corporate aircraft and provided BCL with the data identified in Table 30 for each aircraft company.*

To establish a data base more representative of the entire business/corporate fleet, Battelle-Columbus submitted a sampling plan to ADS for obtaining information on 2,000 additional Business/Corporate aircraft. Unfortunately, each of these additional 2,000 aircraft were necessarily restricted by ADS to be corporate owned aircraft because of the lack of available data on the business descriptors of unincorporated operators. Since no data were available pertaining to strictly noncorporate owners, it was not possible to divide the analysis of business/corporate ownership characteristics into corporate and noncorporate ownership categories. Furthermore, of the 2,000 additional aircraft provided by ADS, 357 are aircraft that are owned by

* Actually only 997 companies are contained in the data base; aircraft operated by Beech, Cessna, and Piper were excluded.

TABLE 30. AVAILABLE INFORMATION ON "FORTUNE 1000" AIRCRAFT

I. Aircraft Description

A. Manufacturer
B. Model
C. FAA aircraft type

II. Distribution of Business Fleet

A. Name of operating company
B. Rank based on net sales
C. Listing of number, type, and model of aircraft operated by the company
D. Summary of aircraft by type, manufacturer, and percentage of business fleet.

III. Company Characteristics

A. Company name
B. SIC Code
C. Location (city and state)
D. Sales
E. Net income
F. Number of employees
G. Total assets
H. Stockholder's equity

corporations but probably not used primarily for "the purposes of transporting its employees and/or property". Sixty-four of the 357 aircraft are owned by certificated and noncertificated air carriers (SIC codes 4511 and 4512); the remaining 293 belong to SIC codes 4582, 4583, 5599, 7394, and 8299 which include airport operators, retail aircraft dealers, airplane rental companies, and flying schools. The problem typifies the confusion which has permeated the general aviation system regarding the definition of the business/corporate user category.

The intent of the sampling plan was that the ratio of the number of aircraft within each type to the total number of aircraft in the sample (3,341) would be equal to the ratio of the total number of aircraft within that type to the total corporate aircraft population. Since most of the more expensive aircraft are contained in the "Fortune 1000" data base, some bias is evident. Only that information listed under Items I and II of Table 30 could be obtained for these additional aircraft. This was unfortunate in that the most realistic correlations would probably be obtained by comparing the total net worth (or size) of a company's fleet with some measure of its financial size or performance. Similarly, an individual company's fleet size may have correlated with the type of industry, as indicated by SIC code.

Despite these anomalies, the data sample is adequate for the purpose of this study, particularly since the aircraft/companies have been segregated by SIC code. However, since no activity data were available for these individual aircraft, the results of this section must stand alone; they cannot be incorporated into other portions of this program, except as the insight provided by each distinct program task presents a more complete understanding of the entire business/corporate fleet.

SIC Code Groupings

From the data provided by ADS, several significant financial ratios may be constructed. Among them are the following.

(1) Net Income/Net Worth - This ratio is a measure of the profit returned to a firm's owners (i.e., stockholders) in terms of percentage of their investment. Without a minimum long-term return on investment which exceeds bank savings or government bonds, the firm could no longer continue operation.

(2) Sales/Net Worth - This ratio measures to what degree the firm's sales volume is supported by capital invested by the owners. A high value implies that the firm is using heavy debt or high credit to finance its operations. A low value indicates the firm is not utilizing its capital at a productive rate.

(3) Net Income/Sales - This describes the relative efficiency of the firm to produce profits after taking into account all expenses and income taxes.

These ratios are generally meaningful when making comparison within the same industry. Therefore, the financial ratios corresponding to each individual corporate aircraft user must be nondimensionalized with respect to the average value of that ratio within the corporation's particular industry.

The combined data sample consisting of the "Fortune 1000" aircraft plus the additional 2000 aircraft was searched in order to identify all distinct two-digit SIC codes. Sixty-nine different values were found. For each of these 69 SIC codes, industry-wide average values were determined for the three financial ratios discussed above.* These SIC codes were further condensed into nine major divisions, as identified in the SIC manual. Cumulative distribution for the number of aircraft/companies and correlations as a function of the normalized financial ratios were analyzed according to these nine major divisions. Table 31 presents the 69 two-digit SIC codes identified, values of their industry-wide average financial ratios, and the groupings within the nine major divisions. The major divisions are

A: Agriculture, forestry, and fishing

B: Mining

* Troy, Leo, Almanac of Business and Industrial Financial Ratios, Prentice-Hall, Inc., 1974 Edition.

TABLE 31. INDUSTRY-WIDE AVERAGE FINANCIAL RATIO VALUES BY SIC CODE

Major Division	SIC	N.I./N.W.	Sales/N.W.	N.I./Sales
A	01	.087	2.7	.032
	02	.087	2.7	.032
	07	.126	5.7	.022
	08	.126	5.7	.022
	09	.126	5.7	.022
B	10*	.037	0.6	.061
	12	.120	2.1	.057
	13	.124	1.6	.078
	14	.059	1.6	.037
C	15	.179	10.9	.016
	16	.102	4.8	.021
	17	.179	7.7	.023
D	20*	.089	3.6	.025
	21*	.125	2.1	.059
	22*	.080	3.1	.026
	23*	.112	5.1	.022
	24*	.071	2.4	.030
	25*	.099	3.4	.029
	26*	.100	2.4	.042
	27*	.105	2.8	.038
	28*	.100	2.1	.047
	29*	.077	2.2	.035
	30*	.095	3.5	.027
	31*	.079	2.9	.027
	32*	.061	2.1	.209
	33*	.029	1.6	.018
	34*	.079	2.8	.028
	35*	.086	2.4	.036
	36*	.066	2.6	.205
	37*	.059	2.8	.021
	38*	.101	2.0	.050
	39*	.073	2.8	.026

Major Division	SIC	N.I./N.W.	Sales/N.W.	N.I./Sales
E	41	.053	3.2	.016
	42	.086	3.6	.024
	44	.057	1.9	.030
	45	.011	2.8	.004
	46	.091	1.2	.076
	47	.102	4.4	.023
	48*	.083	1.7	.049
	49	.051	0.9	.057
F	50*	.112	5.6	.020
	51	.086	6.4	.013
G	52	.088	4.2	.021
	53	.092	4.1	.022
	54	.108	11.3	.009
	55	.109	10.4	.010
	56	.117	4.2	.028
	57	.098	4.4	.022
	58	.141	5.8	.024
	59	.119	5.7	.021
H	60	.042	0.8	.052
	61	.058	1.0	.058
	62	.092	1.7	.054
	63	.053	2.0	.026
	64	.184	2.8	.066
	65	.075	0.6	.125
	66	.140	2.1	.067
	67*	.059	--	--
I	70	.087	2.0	.044
	72	.110	3.3	.033
	73	.116	3.4	.034
	75	.119	4.0	.030
	76	.161	5.2	.031
	78*	.111	2.5	.044
	79	.124	2.1	.059
	82	.188	6.1	.031
	89	.178	5.4	.033

* indicates within "Fortune 1000" data.

C: Construction

D: Manufacturing

E: Transportation, communications, electricity, gas, and sanitary services

F: Wholesale trade

G: Retail trade

H: Finance, insurance, and real estate

I: Services

"Fortune 1000" Companies

Figures 6 and 7 indicate the percentage of "Fortune 1000" companies which own business/corporate aircraft within a particular sales bracket and a comparison of the distribution of aircraft types between the "Fortune 1000" fleet and the entire business/corporate fleet. It is not surprising that the larger companies (by sales) are more likely to operate business aircraft, nor that the "Fortune 1000" distribution of aircraft types is more skewed towards the more expensive aircraft.

Tables 32, 33, and 34 show cross tabulations of number of aircraft operated by a company (fleet size) by company sales, company assets, and number of employees for the 427 "Fortune 1000" companies operating aircraft.

Presentation of Company Characteristics

Sample Distribution

Figures 8 through 16 present the distribution of company-owned aircraft as a function of normalized financial ratios. Each figure contains the distribution with respect to each of three financial ratios for a particular industry. As might be expected, the financial performance of most companies owning business/corporate aircraft clusters about a value of 1.0 for each normalized ratio. Since the number of aircraft is a discrete observation, this is indicative of the fact that most companies (with or without business aircraft) have a financial performance near the industry-wide average.

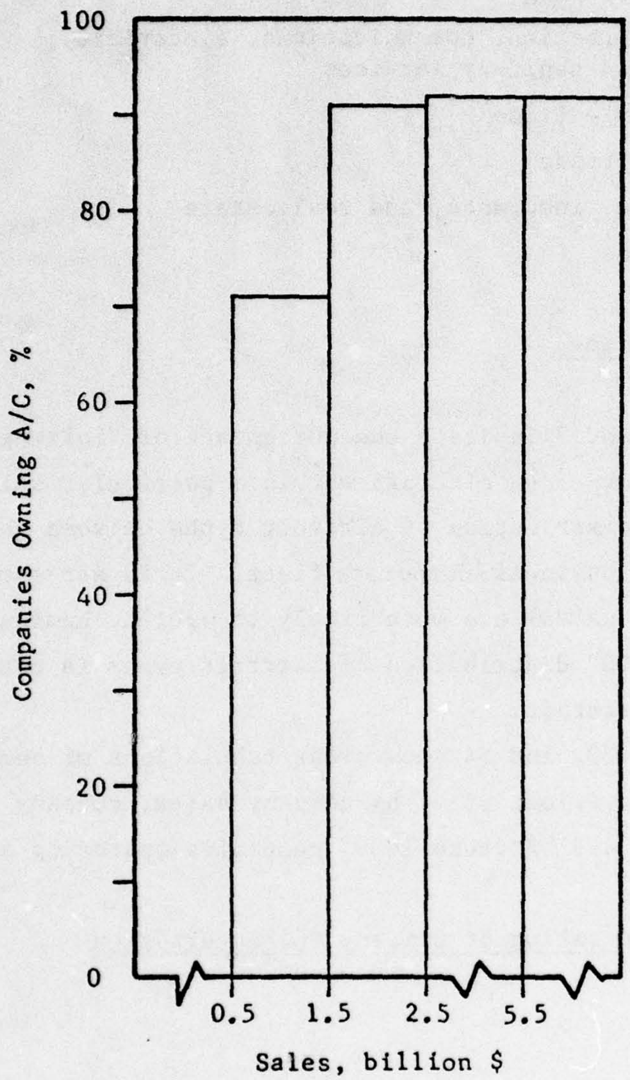

FIGURE 6. PERCENTAGE OF FORTUNE 1000 COMPANIES WHICH OPERATE BUSINESS AIRCRAFT

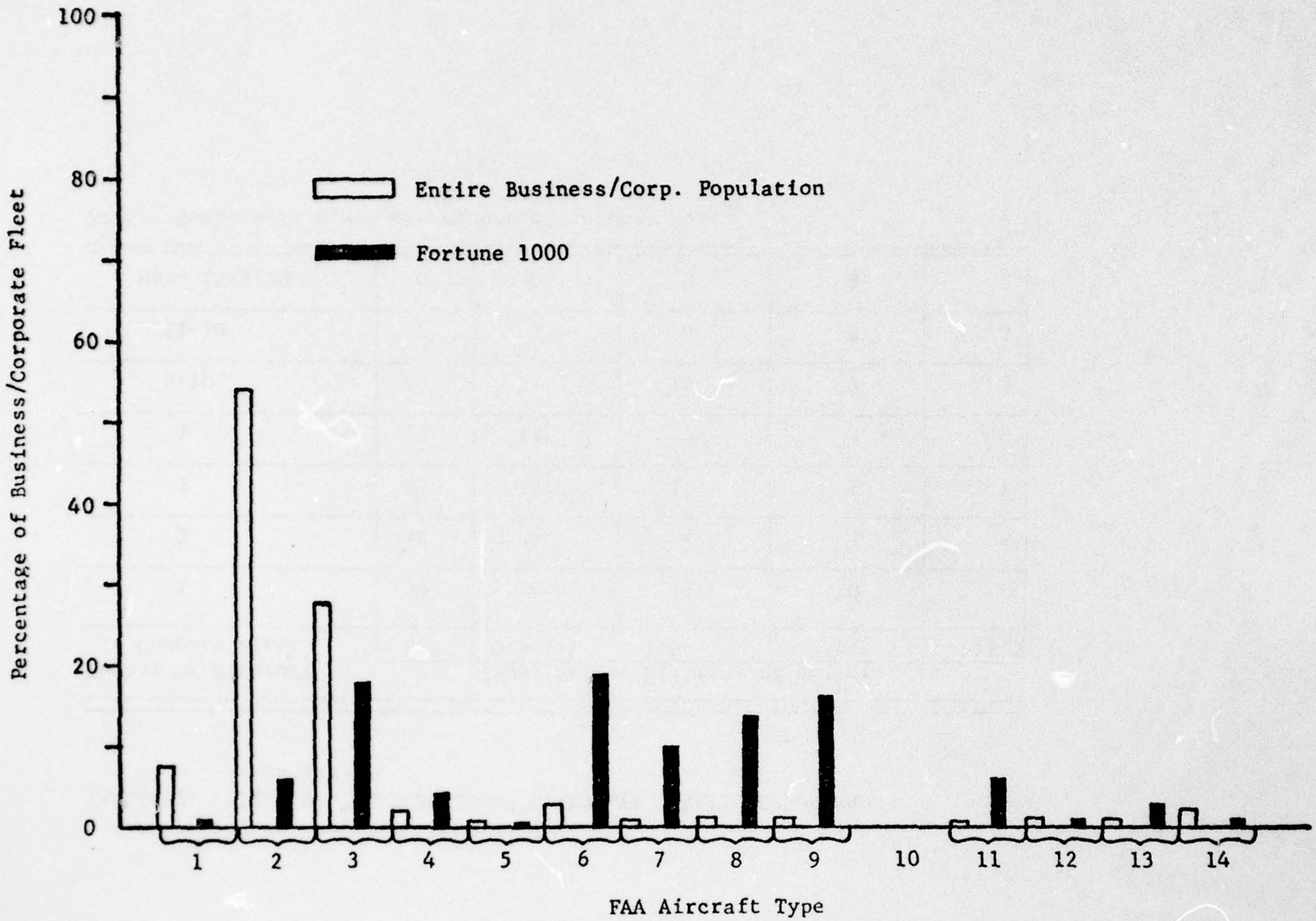

FIGURE 7. DISTRIBUTION BY AIRCRAFT TYPE

TABLE 32. SIZES OF "FORTUNE 1000" CORPORATE FLEETS VERSUS GROSS SALES (1972)

Number of Aircraft in Company Fleet	Gross Sales, billions of dollars				
	< 0.5	0.5-1.5	1.5-2.5	2.5-5.5	> 5.5
1	139	31	5	0	0
2	48	34	6	5	0
3	15	19	12	1	1
4	12	11	7	3	0
5-10	10	21	15	7	5
11-20	0	5	4	3	3
More than 20	0	0	0	3	2

NOTE: Numbers in boxes are number of corporations.

TABLE 33. SIZES OF "FORTUNE 1000" CORPORATE FLEETS VERSUS ASSETS (1972)

Number of Aircraft in Company Fleet	Assets - Billions of Dollars					
	0.5	0.5-1.5	1.5-2.5	2.5-5.5	5.5-9.5	9.5
1	147	26	2	0	0	0
2	54	31	6	2	0	0
3	18	21	8	1	0	0
4	15	10	6	2	0	0
5-10	12	19	13	8	3	3
11-20	1	4	4	2	2	2
More than 20	0	0	0	3	2	0

NOTE: Numbers in boxes are number of corporations.

TABLE 34. SIZES OF "FORTUNE 1000" CORPORATE FLEETS VERSUS NUMBER OF EMPLOYEES (1972)

Number of Aircraft in Company Fleet	Number of Employees						
	0 to 4,999	5,000 to 14,999	15,000 to 24,999	25,000 to 34,999	35,000 to 54,999	55,000 to 94,999	>95,000
1	74	61	17	10	6	7	0
2	14	35	13	15	9	5	2
3	5	13	11	4	9	4	2
4	8	6	3	6	2	5	3
5-10	6	7	7	12	10	8	8
11-20	0	1	1	2	4	3	4
More than 20	0	0	0	1	2	2	0

NOTE: Numbers in boxes are number of corporations.

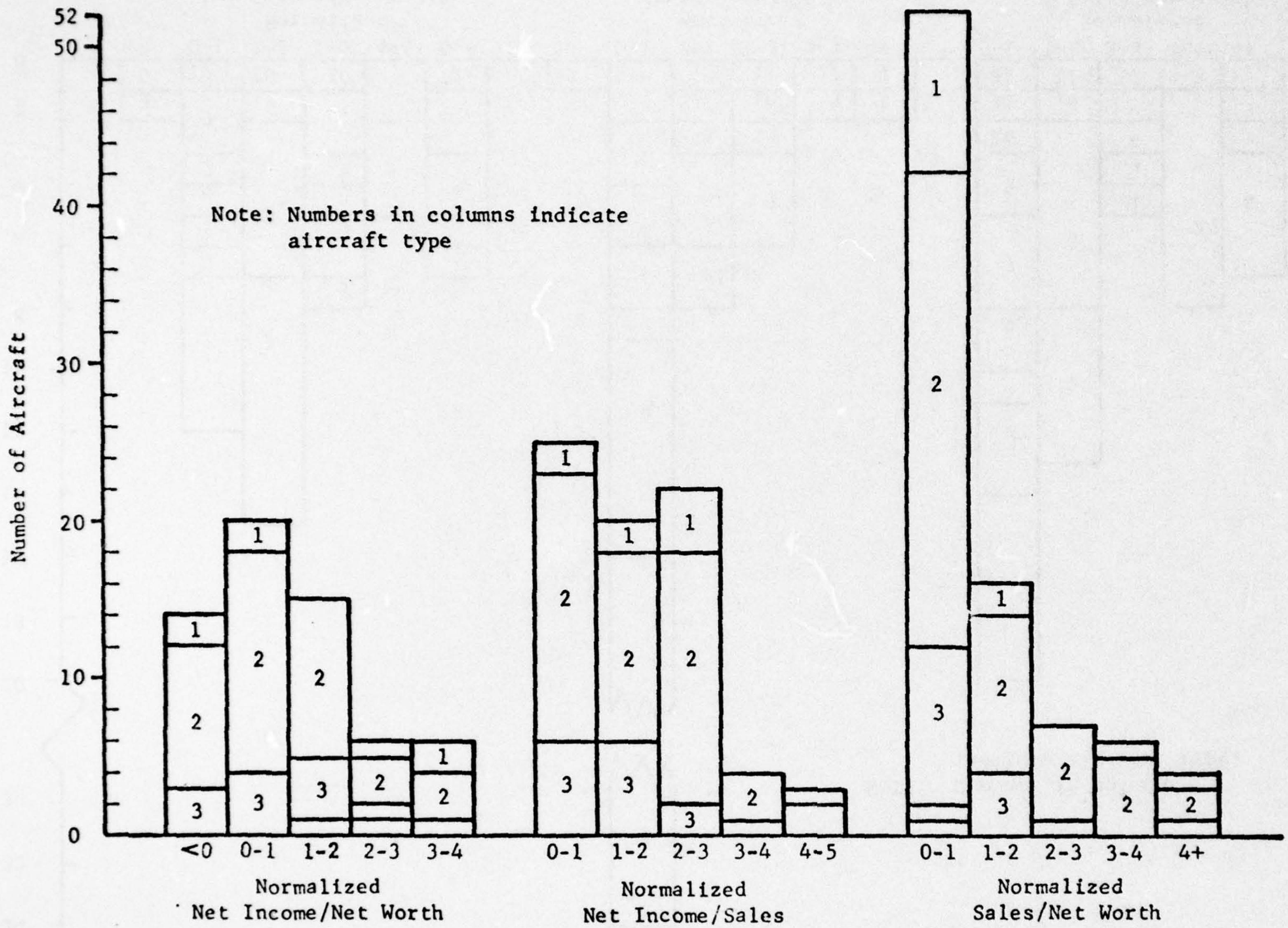

FIGURE 8. DISTRIBUTION OF AIRCRAFT - AGRICULTURE INDUSTRY

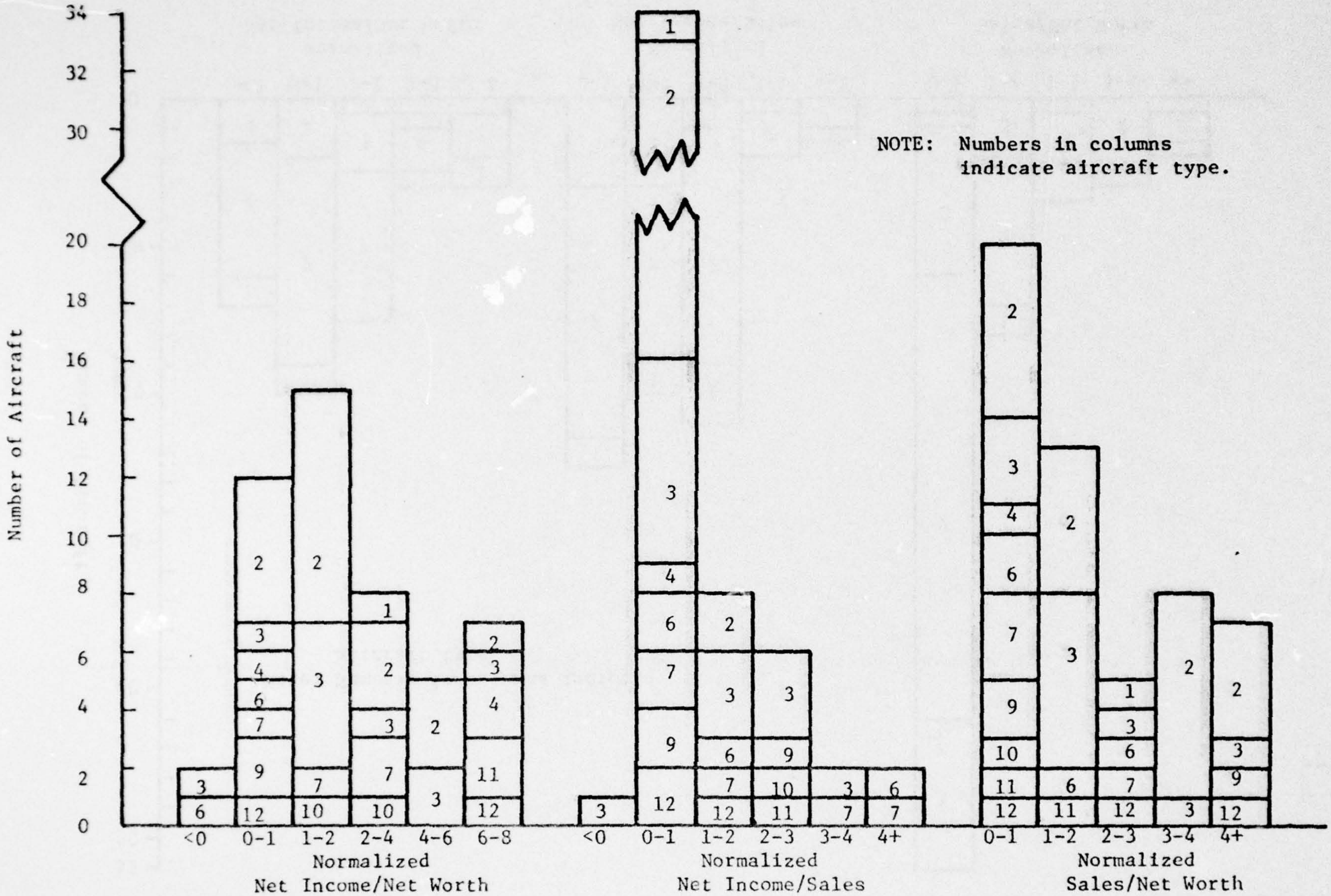

FIGURE 9. DISTRIBUTION OF AIRCRAFT - MINING INDUSTRY

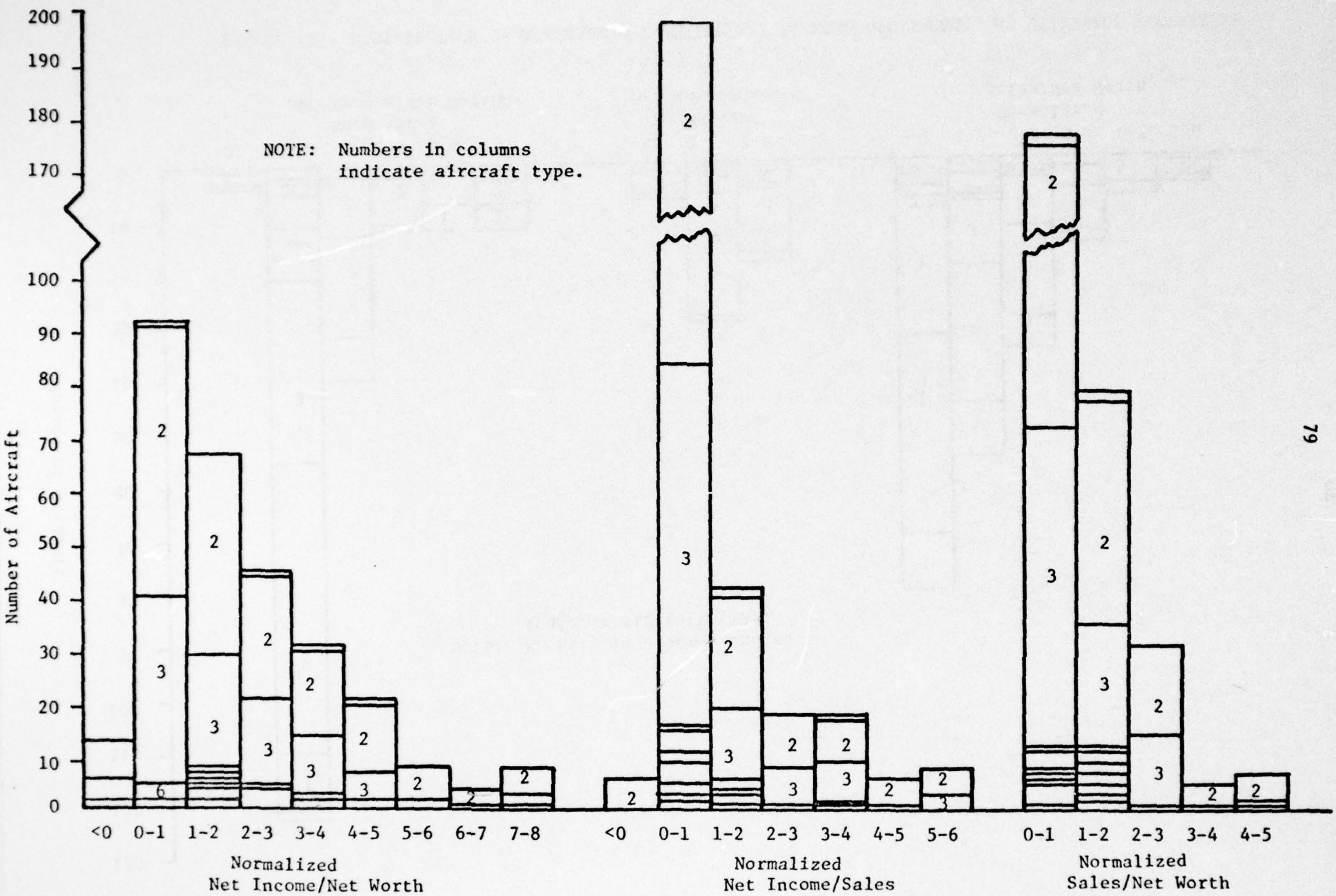

FIGURE 10. DISTRIBUTION OF AIRCRAFT - CONSTRUCTION INDUSTRY

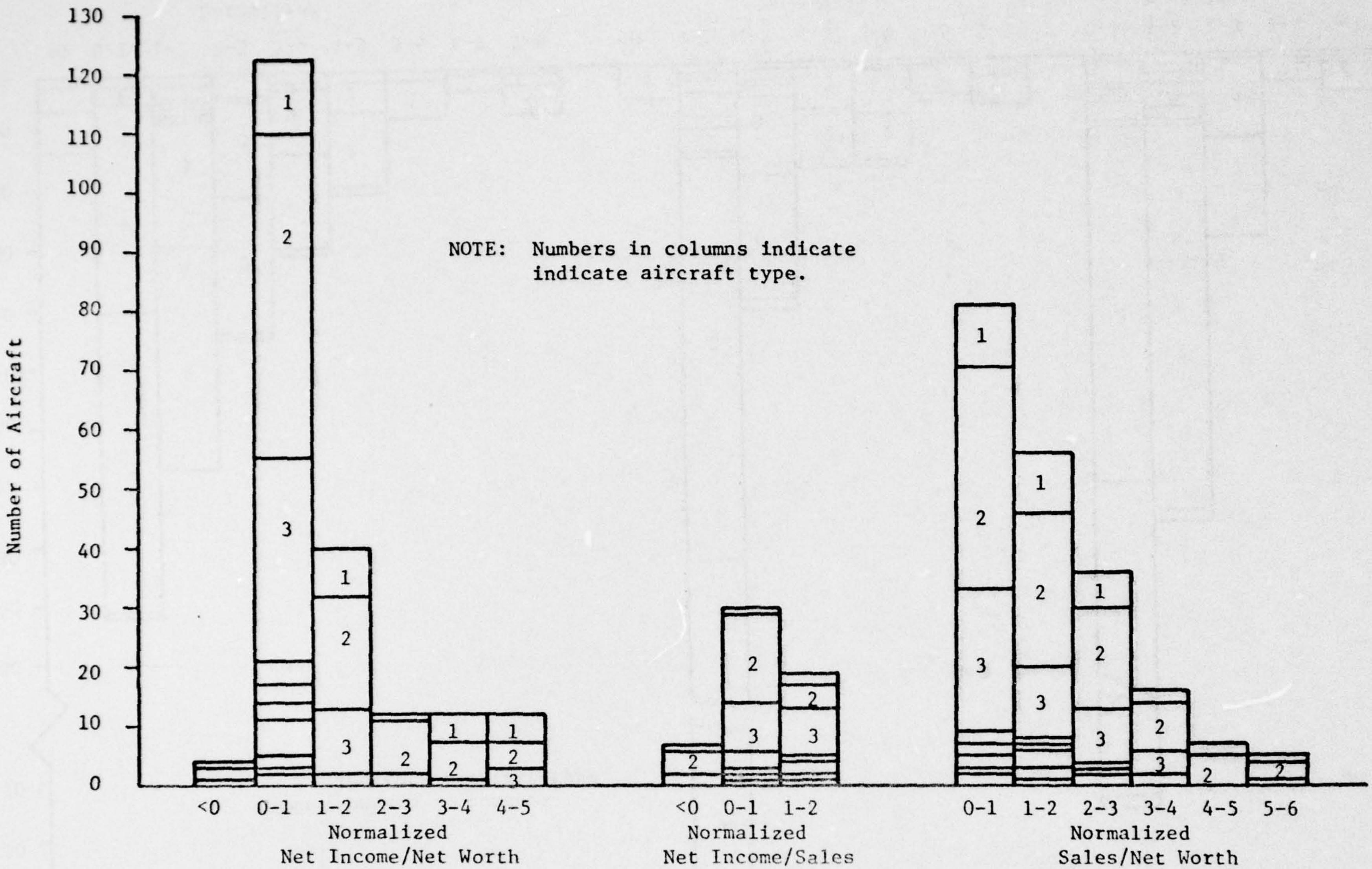

FIGURE 11. DISTRIBUTION OF AIRCRAFT - TRANSPORTATION, COMMUNICATIONS, AND UTILITIES INDUSTRIES

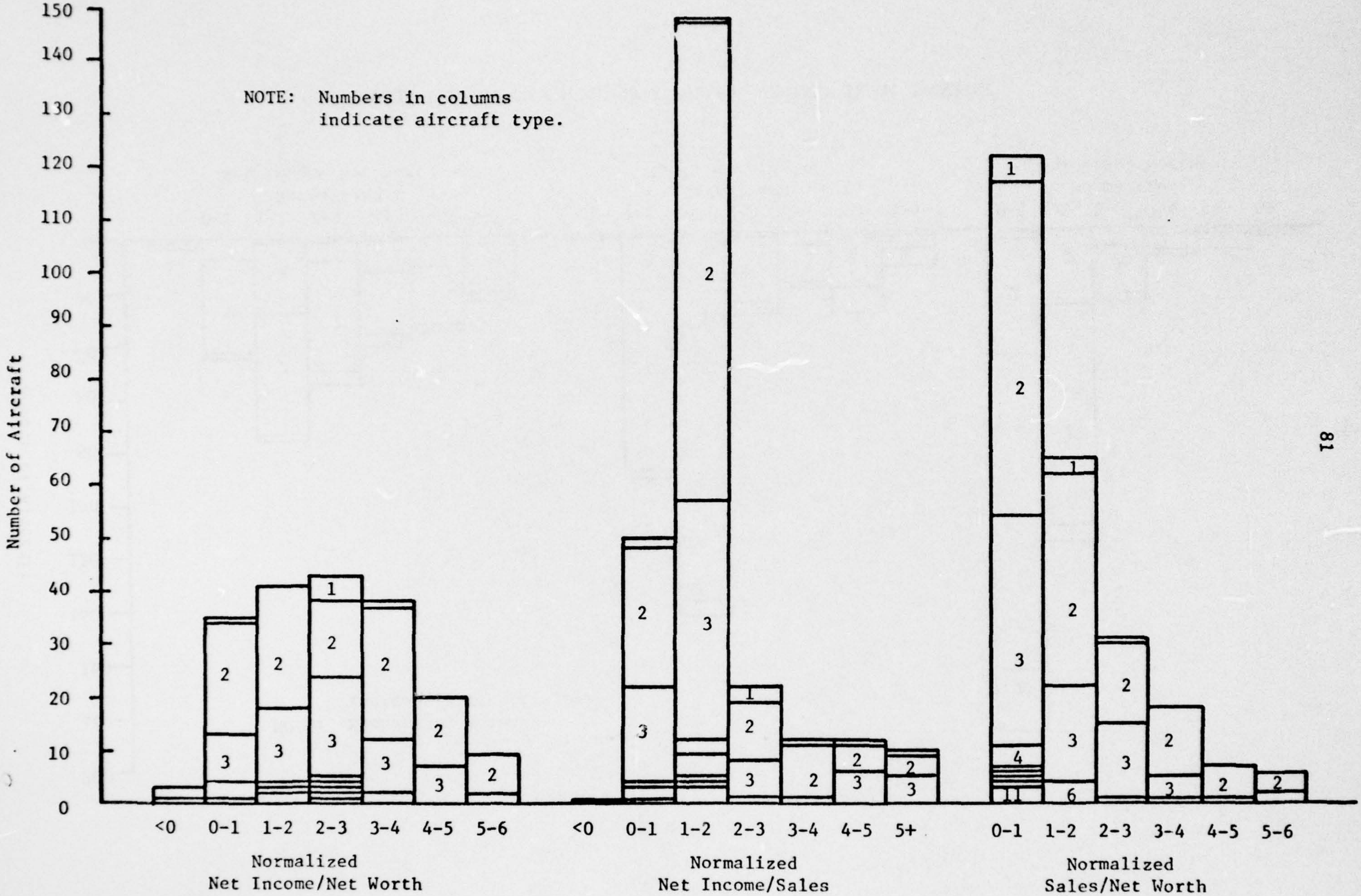

FIGURE 12. DISTRIBUTION OF AIRCRAFT - WHOLESALE TRADE INDUSTRY

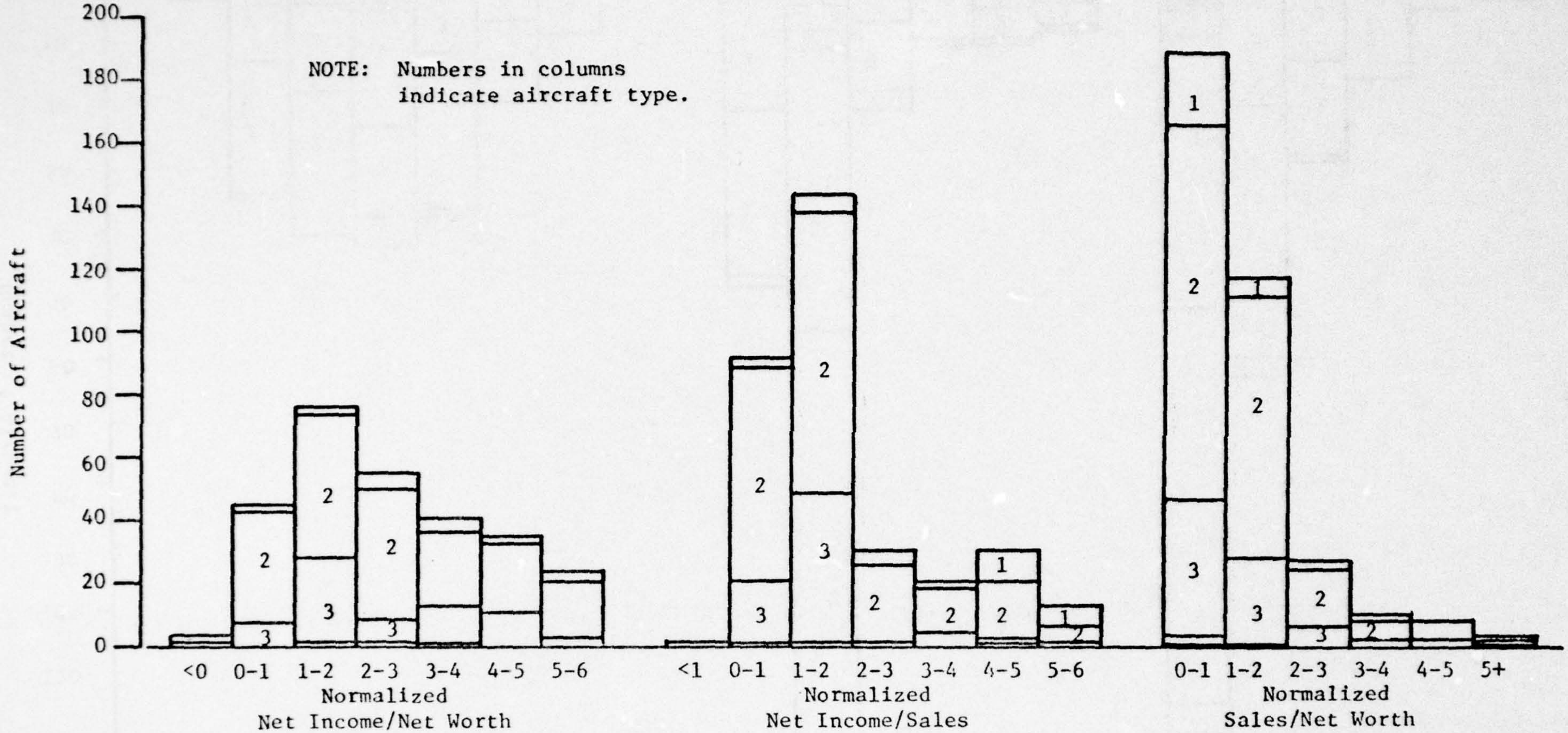

FIGURE 13. DISTRIBUTION OF AIRCRAFT - RETAIL TRADE INDUSTRY

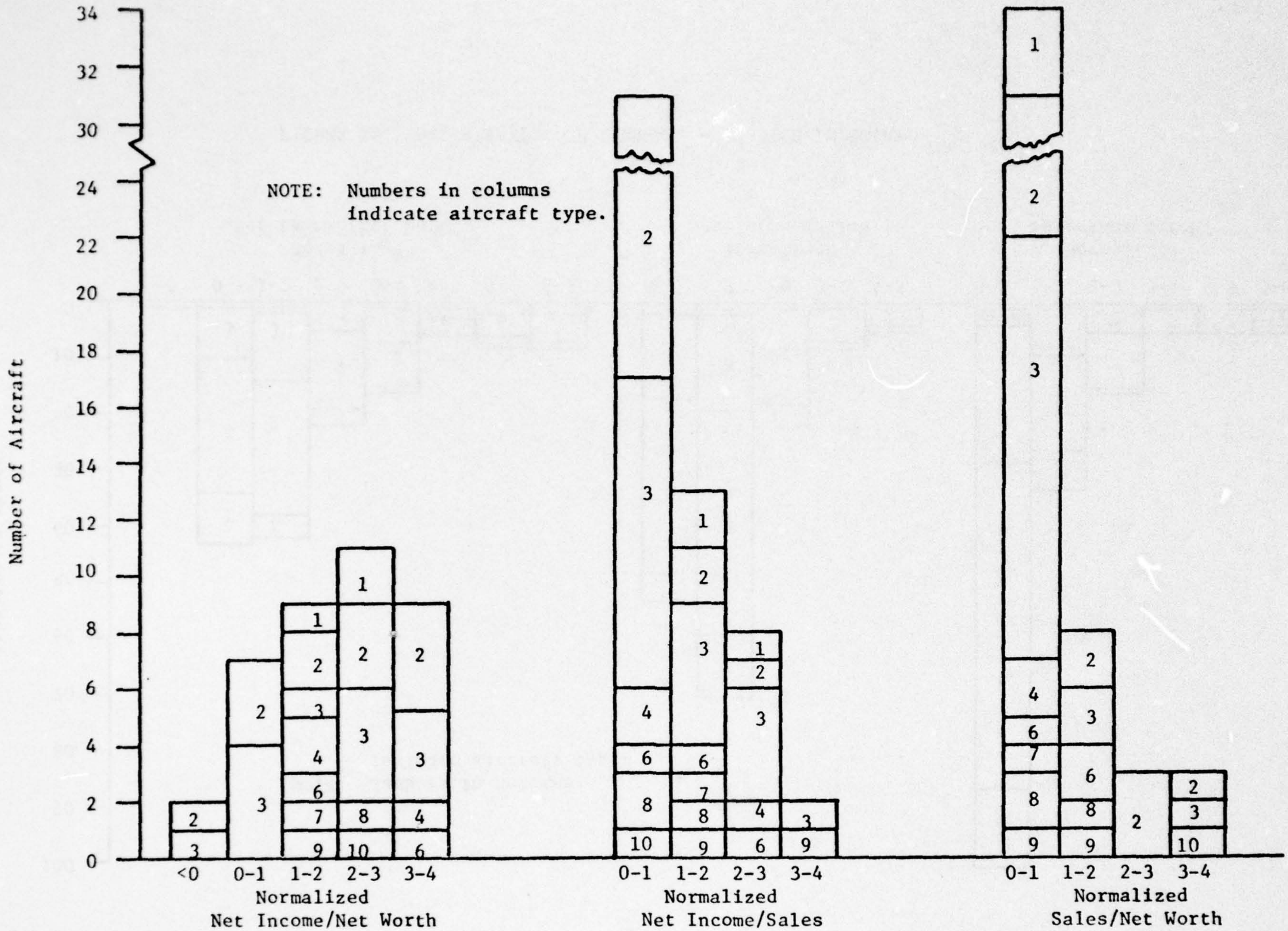

FIGURE 14. DISTRIBUTION OF AIRCRAFT - FINANCE, INSURANCE, AND REAL ESTATE

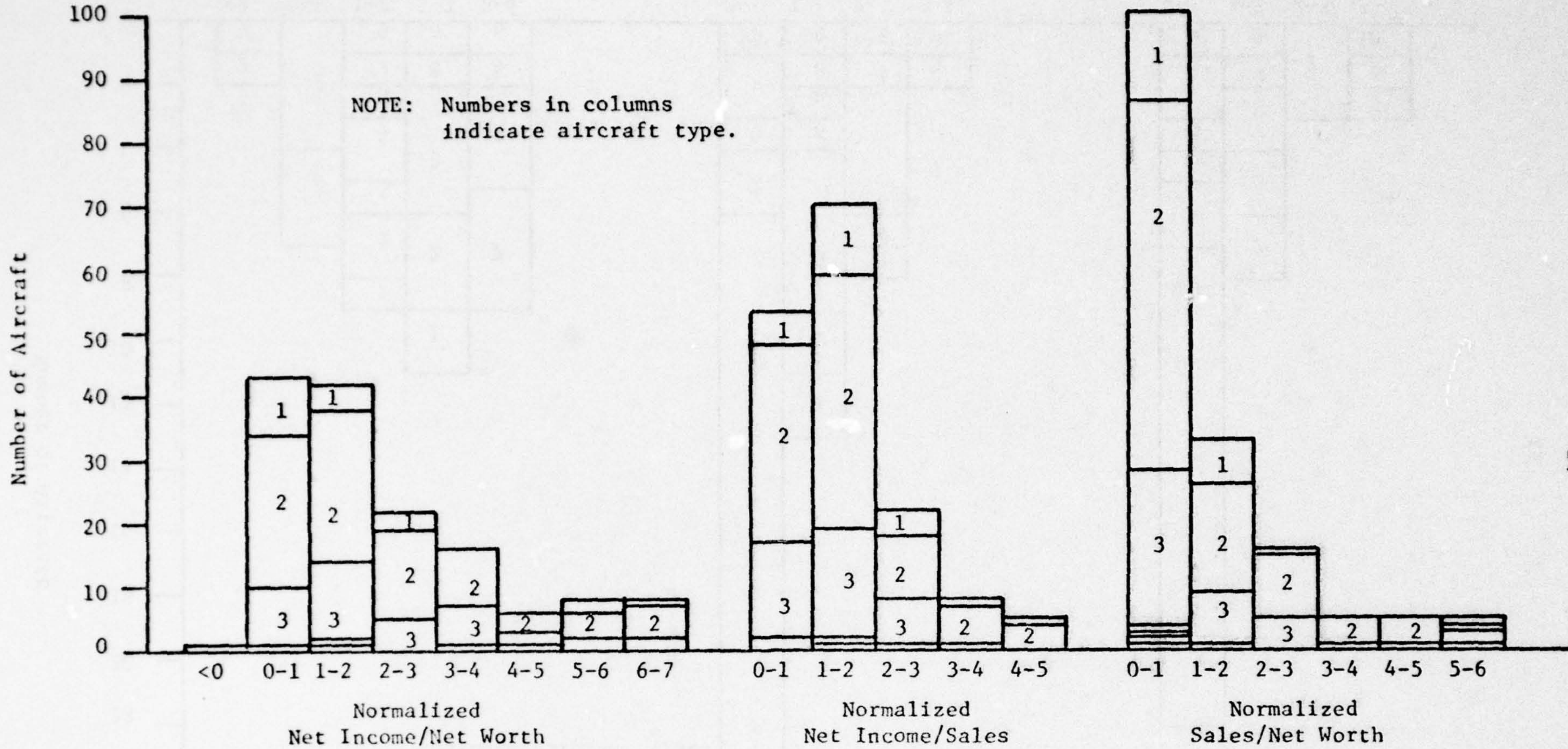

FIGURE 15. DISTRIBUTION OF AIRCRAFT - SERVICE INDUSTRY

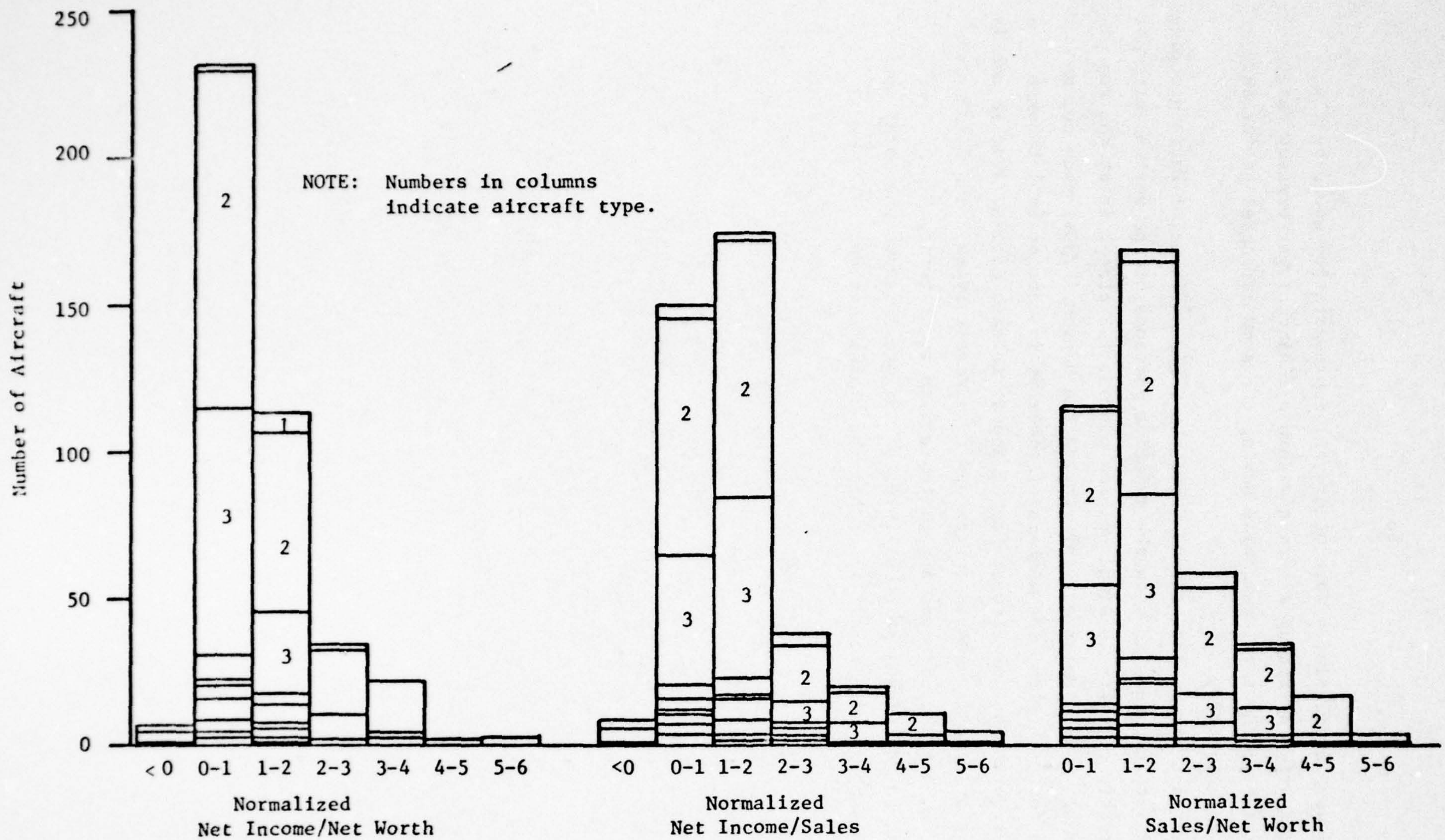

FIGURE 16. DISTRIBUTION OF AIRCRAFT - MANUFACTURING

If the data were available, a more meaningful representation would be the number of companies operating aircraft within a financial performance range as a percentage of the total companies having the same financial performance within the same industry.

In each figure the columns above the various financial ratio groupings are divided into segments to show the relative portions of the various aircraft types. Aircraft category 1 (single-engine piston, 1-3 place) is at the top and the larger, more complex aircraft toward the bottom. Thus, each column shows, from top to bottom, the numbers of aircraft in categories 1 through 14 in that order. Not all aircraft types appear in each column, and, in nearly all cases, the largest segments correspond to aircraft Types 2 and 3, single-engine piston, 4 place or more, and piston-engine light twins.

As an additional point of interest, Figure 17 shows the total number, in the data sample, of aircraft in each major classification.

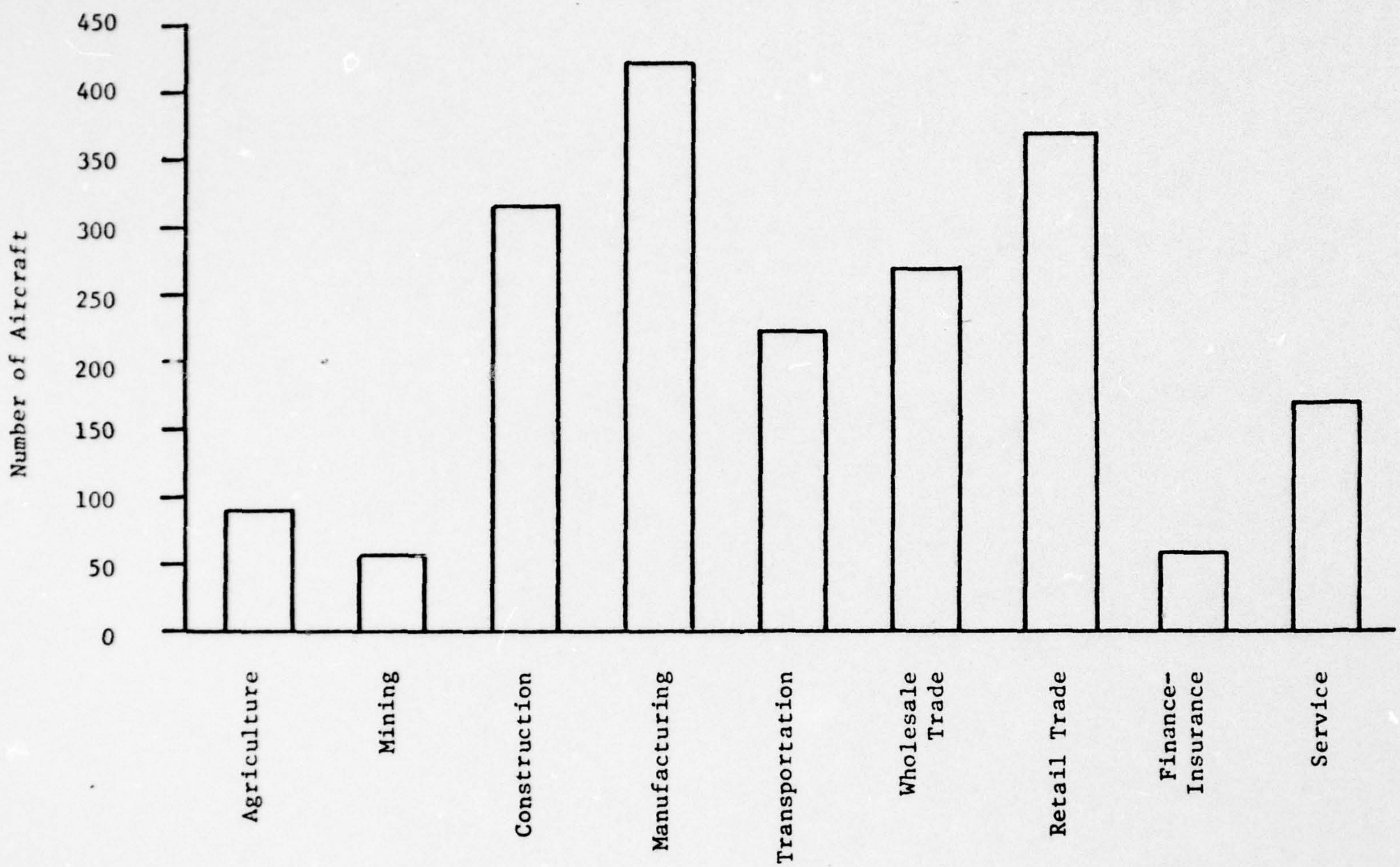

FIGURE 17. NUMBER OF AIRCRAFT IN SAMPLE, BY SIC GROUPING

AD-A036 364   BATTELLE COLUMBUS LABS OHIO   F/G 1/2
STUDY OF THE EFFECTS OF INCREASED COSTS ON CORPORATE AND BUSINE--ETC(U)
AUG 75 R F PORTER, M A DUFFY, R W COTE   DOT-FA74WA-3485
UNCLASSIFIED   FAA-AVP-75-13-VOL-2   NL

2 OF 2
AD-A
036 364

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APPENDIX A

LISTING OF FORTRAN PROGRAM FOR COMPUTING ANNUALIZED INVESTMENT

```
 'ROGRAM FAA(INPUT,OUTPUT)
 DIMENSION ACPRICE(10),DISPRC(10),PLTSAL(10),DOWNPAY(10),TERM(10),
1        EXTRATE(10),SERVICE(10),RESID(10),
1     AI(12,10,24),AIDISC(10,24),SALARY(12),DEPREC(12),ANNINT(12),
1     TAXRED(12)
 REAL INT2,LSEPAY
 REAL INTRATE(10),LSERATE(10),LSETERM(10),MNTSAL(10),LIFE(10),
1        NETCOST(12),DF(12),PV(12)
 DIMENSION ISWACT(24),ISWFIN(24),ISWCREW(24),ISWCORP(24)
 REAL INT
 REAL INFLTN
 INTEGER YEAR
 DIMENSION REPAY(12)
 REAL MNTHPAY
 REAL INTMTH
 DATA(ISWACT(I),I=1,24)/4(0,1,0,1,2,3)/
 DATA(ISWFIN(I),I=1,24)/4(0,0,1,1,2,2)/
 DATA(ISWCREW(I),I=1,24)/2(0,0,0,0,0,0,1,1,1,1,1,1)/
 DATA(ISWCORP(I),I=1,24)/12(0),12(1)/
 READ 11,SALETAX,PITAX,CORPTAX,TAXCRDT,ROI,INFLTN
 FORMAT(10F8.0)
1 FORMAT(10F8.4)
 READ 10,ACPRICE
 READ 11,DOWNPAY
 READ 10,TERM
 READ 11,INTRATE
 READ 11,LSERATE
 READ 10,LSETERM
 READ 10,EXTRATE
 READ 11,DISPRC
 READ 10,PLTSAL
 READ 10,MNTSAL
 READ 10,LIFE
 READ 10,SERVICE
 READ 11,RESID
 PRINT 11,SALETAX,PITAX,CORPTAX,TAXCRDT,ROI,INFLTN
 PRINT 10,ACPRICE
 PRINT 11,DOWNPAY
 PRINT 10,TERM
 PRINT 11,INTRATE
 PRINT 11,LSERATE
 PRINT 10,LSETERM
 PRINT 10,EXTRATE
 PRINT 11,DISPRC
 PRINT 10,PLTSAL
 PRINT 10,MNTSAL
 PRINT 10,LIFE
 PRINT 10,SERVICE
 PRINT 11,RESID
 DO 100 K=1,24
 DO 200 J=1,10
   NCPL=ACPRICE(J)*(1.-DOWNPAY(J))*(1.+SALETAX)
 INTMTH=INTRATE(J)/12.
 II=SERVICE(J)
 R=(1.+INTMTH)**(12.*TERM(J))
```

```
      MNTHPAY=PRNCPL*(INTMTH*R/(R-1.))
      PR2=ACPRICE(J)*(1.+SALETAX)
      INT2=LSERATE(J)/12.
      R2=(1.+INT2)**(12.*LSETERM(J))
      LSEPAY=PR2*(INT2*R2/(R2-1.))
      SUMPV=0.0
      SUMDF=0.0
      DO 300 I=1,I1
      ANNINT(I)=0.0
      IF(ISWFIN(K).NE.1) GO TO 402
      IF(I.GT.TERM(J)) GO TO 401
      DO 400 L=1,12
      INT=INTMTH*PRNCPL
      PRN=MNTHPAY-INT
      PRNCPL=PRNCPL-PRN
  400 ANNINT(I)=ANNINT(I)+INT
      GO TO 402
  401 ANNINT(I)=0.
  402 IF(ISWACT(K).GT.0) GO TO 405
      DEPREC(I)=ACPRICE(J)*(1.-RESID(J))/LIFE(J)
      IF(I.GT.LIFE(J)) DEPREC(I)=0.
      GO TO 420
  405 IF(ISWACT(K).GT.1) GO TO 415
      IF(I.GT.LIFE(J)) GO TO 415
      DEPREC(I)=((1.-2./LIFE(J))**(I-1))*(2./LIFE(J))*ACPRICE(J)*(1.-
     1      RESID(J))
      IF(I.LT.(LIFE(J)/2.+1.)) GO TO 410
      DEPREC(I)=((1.-2./LIFE(J))**(I-1))*(1./(LIFE(J)-I+1.))*ACPRICE(J)*
     1     (1.-RESID(J))
      IF(I.LT.(LIFE(J)/2.+2.)) GO TO 410
      I9=I-1
      DEPREC(I)=DEPREC(I9)
  410 IF(I.LE.LIFE(J)) GO TO 420
  415 DEPREC(I)=0.
  420 CONTINUE
      IF(ISWFIN(K).NE.0) GO TO 440
      REPAY(I)=0.
      REPAY(1)=ACPRICE(J)*(1.+SALETAX)
      GO TO 443
  440 IF(ISWFIN(K).NE.1) GO TO 442
      REPAY(I)=12.*MNTHPAY
      IF(I.GT.TERM(J)) REPAY(I)=0.
      REPAY(1)=12.*MNTHPAY+DOWNPAY(J)*ACPRICE(J)*(1.+SALETAX)
      GO TO 443
  442 REPAY(I)=12.*LSEPAY
  443 CONTINUE
  445 IF(ISWCREW(K).LT.1) GO TO 450
      SALARY(I)=0.
      GO TO 451
  450 SALARY(I)=(PLTSAL(J)+MNTSAL(J))
  451 CONTINUE
      IF(ISWFIN(K).NE.1) ANNINT(I)=0.
      IF(ISWFIN(K).NE.2) LSEPAY=0.
      IF(ISWFIN(K).EQ.2) DEPREC(I)=0.
      IF(ISWCORP(K).GT.0) GO TO 460
      CREDIT1=SALETAX*ACPRICE(J)
```

```
      CREDIT=ACPRICE(J)*TAXCRDT
      IF(I.GT.1) CREDIT1=0.
      IF(I.GT.1) CREDIT=0.
      TAXRED(I)=CORPTAX*(SALARY(I)+DEPREC(I)+ANNINT(I)+LSEPAY*12.+
     1    CREDIT1) + CREDIT
      GO TO 470
  460 CREDIT1=SALETAX*ACPRICE(J)
      IF(I.GT.1) CREDIT1=0.
      TAXRED(I)=PITAX*(SALARY(I)+DEPREC(I)+ANNINT(I)+LSEPAY*12.+CREDIT1)
  470 NETCOST(I)=SALARY(I)+REPAY(I)-TAXRED(I)
      AI(I,J,K)=NETCOST(I)
      DF(I)=1./(1.+ROI)**I
      PV(I)=NETCOST(I)*DF(I)
      SUMPV=SUMPV+PV(I)
  300 SUMDF=SUMDF+DF(I)
  200 AIDISC(J,K)=SUMPV/SUMDF
  100 CONTINUE
      I5=SERVICE(1)
      DO 480 J1=1,10
      IF(SERVICE(J1).GT.I5) I5=SERVICE(J1)
  480 CONTINUE
      I5=I5+1
       DO 600 I=1,I5
      IF(I.LT.I5) GO TO 601
      DO 602 K=1,24
      DO 602 J=1,10
  602 AI(I,J,K)=AIDISC(J,K)
      PRINT 501
  501 FORMAT(1H1,30X,*EQUIVALENT ANNUAL COST ($/YEAR) -- BASED ON DCF AN
     1ALYSIS*)
      GO TO 504
  601 CONTINUE
      YEAR=I
      PRINT 500,YEAR
  500 FORMAT(1H1,60X,*YEAR *,I2)
  504 CONTINUE
      PRINT 505
  505 FORMAT(1H0,55X,*AIRCRAFT TYPE*)
      PRINT 510
  510 FORMAT(1H ,34X,*1*,9X,*2*,9X,*3*,9X,*4*,9X,*5*,9X,*6*,9X,*7*,9X,*8
     1*,9X,*9*,9X,*10*)
      PRINT 515,(AI(I,J,24),J=1,10)
  515 FORMAT(1H ,19X,*DRY*,8X,10(F8.0,2X))
      PRINT 520
  520 FORMAT(1H ,13X,*LEASE*)
      PRINT 525,(AI(I,J,23),J=1,10)
  525 FORMAT(1H ,19X,*WET*,8X,10(F8.0,2X))
      PRINT 530,(AI(I,J,22),J=1,10)
  530 FORMAT(1H0,19X,*ACCEL*,6X,10(F8.0,2X))
      PRINT 535
  535 FORMAT(1H ,5X,*NON PRO*,1X,*FINCE*)
      PRINT 540,(AI(I,J,21),J=1,10)
  540 FORMAT(1H ,19X,*ST LINE*,4X,10(F8.0,2X))
      PRINT 530,(AI(I,J,20),J=1,10)
      PRINT 545
  545 FORMAT(1H ,13X,*OWN*)
```

```
      PRINT 540,(AI(I,J,19),J=1,10)
      PRINT 541
      PRINT 515,(AI(I,J,18),J=1,10)
      PRINT 520
      PRINT 525,(AI(I,J,17),J=1,10)
      PRINT 530,(AI(I,J,16),J=1,10)
      PRINT 550
  550 FORMAT(1H ,5X,*PRO*,5X,*FINCE*)
      PRINT 540,(AI(I,J,15),J=1,10)
      PRINT 530,(AI(I,J,14),J=1,10)
      PRINT 545
      PRINT 540,(AI(I,J,13),J=1,10)
  541 FORMAT(1H ,*PRIV*)
      PRINT 515,(AI(I,J,12),J=1,10)
      PRINT 520
      PRINT 525,(AI(I,J,11),J=1,10)
      PRINT 530,(AI(I,J,10),J=1,10)
      PRINT 535
      PRINT 540,(AI(I,J,9),J=1,10)
      PRINT 530,(AI(I,J,8),J=1,10)
      PRINT 545
      PRINT 540,(AI(I,J,7),J=1,10)
      PRINT 555
  555 FORMAT(1H ,*CORP*)
      PRINT 515,(AI(I,J,6),J=1,10)
      PRINT 520
      PRINT 525,(AI(I,J,5),J=1,10)
      PRINT 530,(AI(I,J,4),J=1,10)
      PRINT 550
      PRINT 540,(AI(I,J,3),J=1,10)
      PRINT 530,(AI(I,J,2),J=1,10)
      PRINT 545
      PRINT 540,(AI(I,J,1),J=1,10)
  600 CONTINUE
      STOP
      END
```

APPENDIX B

ANNUAL OUT-OF-POCKET COSTS USED
IN CALCULATING ANNUALIZED INVESTMENT

YEAR 1

AIRCRAFT TYPE

		1	2	3	6	7	8	9	11	12	13
RIV NON PRO	LEASE	2172.	3098.	12546.							
	FINCE	6698.	9557.	39312.							
	OWN	18975.	27073.	111683.							
NON PRO	LEASE	80.	113.	283.	-10821.		-19759.			5023.	286.
	FINCE	4332.	6181.	25445.	70786.		129262.			11003.	25694.
	OWN	16797.	23965.	98865.						42666.	
CORP											
PRO	LEASE	19780.	19813.	20683.	13929.	-4406.	7091.	-16569.	-11034.	27052.	27136.
	FINCE	24032.	25881.	45845	95536.	233583.	156112.	330498.	345950.	37853.	52544.
	OWN	36497.	43665.	119265						69516.	

YEAR 2

AIRCRAFT TYPE

			1	2	3	6	7	8	9	11	12	13
??IV	NON PRO	LEASE	2531.	3612.	14662.							
		FINCE	2373.	3386.	13831.							
		OWN	-1174.	-1675.	-6912.							
:ORP	NON PRO	LEASE	1978.	2822.	11455.	38043.		69469.			5023.	11567.
		FINCE	1763.	2515.	10291.	2593.		4736.			4478.	10392.
		OWN	-1631.	-2327.	-9600.						-4143.	
	PRO	LEASE	21678.	22522.	31855.	62793.	138094.	96319.	191243.	202716.	31873.	38417.
		FINCE	21463.	22215.	30691.	27343.	34713.	31586.	40480.	47645.	31328.	37242.
		OWN	18069.	17373.	10800.						22707.	

YEAR 3

AIRCRAFT TYPE

			1	2	3	6	7	8	9	11	12	13
PRIV	NON PRO	LEASE	2531.	3612.	14662.							
		FINCE	2808.	4006.	16358.							
		OWN	-839.	-1197.	-4937.							
	NON PRO	LEASE	1978.	2822.	11455.	38043.		69469.			5023.	11567.
		FINCE	2365.	3376.	13401.	15856.		28954.			6011.	13936.
		OWN	-1165.	-1562.	-6857.						-2959.	
CORP	PRO	LEASE	21678.	22522.	31855.	62793.	138094.	96319.	191243.	202716.	31873.	38417.
		FINCE	22066.	23076.	34201.	40606.	73390.	55804.	96884.	105661.	32861.	43796.
		OWN	18535.	18038.	13543.						23891.	

YEAR 5

AIRCRAFT TYPE

		1	2	3	6	7	8	9	11	12	13
PRIV NON PRO	LEASE	2531.	3612.	14662.							
	FINCE	3374.	4814.	19617.							
	OWN	-499.	-712.	-2939.							
NON PRO	LEASE	1978.	2822.	11455.	38043.		69469.			5023.	11567.
	FINCE	3154.	4499.	18327.	30862.		56356.			8010.	18507.
	OWN	-693.	-989.	-4081.						-1761.	
CORP											
PRO	LEASE	21678.	22522.	31855.	62793.	138094.	96319.	191243.	202716.	31873.	39417.
	FINCE	22854.	24199.	38727.	55612.	117152.	83206.	160703.	171303.	34860.	45357.
	OWN	19007.	18711.	16319.						25099.	

YEAR 6

AIRCRAFT TYPE

			1	2	3	6	7	8	9	11	12	13
PRIV	NON PRO	LEASE	2531.	3612.	14662.							
		FINCE	-499.	-712.	-2939.							
		OWN	-499.	-712.	-2939.							
CORP	NON PRO	LEASE	1979.	2822.	11455.	38043.		69469.			5023.	11567.
		FINCE	-693.	-989.	-4081.	32482.		59315.			-1761.	-4122.
		OWN	-693.	-989.	-4081.						-1761.	
	PRO	LEASE	21679.	22522.	31855.	62793.	138094.	96319.	191243.	202716.	31873.	38417.
		FINCE	19007.	18711.	16319.	57232.	121877.	86165.	167593.	178390.	25089.	22728.
		OWN	19007.	18711.	16319.						25089.	

98

YEAR 7

AIRCRAFT TYPE

			1	2	3	6	7	8	9	11	12	13
IV	NON PRO	LEASE	2531.	3612.	14662.							
		FINCE	-499.	-712.	-2939.							
		OWN	-499.	-712.	-2939.							
	NON PRO	LEASE	1978.	2822.	11455.	38043.		69469.			5023.	11567.
		FINCE	-693.	-989.	-4081.	34241.		62526.			-1761.	-4122.
		OWN	-693.	-989.	-4081.						-1761.	
RP	PRO	LEASE	21678.	22522.	31855.	62793.	138094.	96319.	191243.	202716.	31873.	38417.
		FINCE	19[illegible]7.	18711.	16319.	58991.	127006.	89376.	175073.	186084.	25089.	22725.
		OWN	19017.	18711.	16319.						25089.	

>99

YEAR 8

AIRCRAFT TYPE

		1	2	3	6	7	8	9	11	12	13
PRIV NON PRO	LEASE	R	R	R							
	FINCE	R	R	R							
	OWN	R	R	R							
NON PRO	LEASE	R	R	R	38043.		69469.			5023.	R
	FINCE	R	R	R	54002.		99613.			R	R
	OWN	R	R	R						R	
CORP PRO	LEASE	R	R	R	62793.	138094.	96319.	191243.	202716.	R	R
	FINCE	R	R	R	78752.	184637.	125463.	259118.	272530.	R	R
	OWN	R	R	R						R	

100<

YEAR 9

AIRCRAFT TYPE

			1	2	3	6	7	8	9	11	12	13
RIV	NON PRO	LEASE	R	R	R							
		FINCE	R	R	R							
		OWN	R	R	R							
	NON PRO	LEASE	R	R	R	38043.		69469.			5023.	R
		FINCE	R	R	R	56075.		102399.			R	R
		OWN	R	R	R						R	
ORP												
	PRO	LEASE	R	R	R	62793.	138094.	96319.	191243.	202716.	R	R
		FINCE	R	R	R	80825.	190683.	129249.	267935.	281599.	R	R
		OWN	R	R	R						R	

YEAR 10

AIRCRAFT TYPE

			1	2	3	6	7	8	9	11	12	13
PRIV	NON PRO	LEASE	R	R	R							
		FINCE	R	R	R							
		OWN	R	R	R							
	NON PRO	LEASE	R	R	R	38043.		69469.			5023.	R
		FINCE	R	R	R	58326.		106509.			R	R
		OWN	R	R	R						R	
CORP	PRO	LEASE	R	R	R	62793.	138094.	96319.	191243.	202716.	R	R
		FINCE	R	R	R	83076.	197247.	133359.	277508.	291445.	R	R
		OWN	R	R	R						R	

EQUIVALENT ANNUAL COST ($/YEAR) -- BASED ON DCF ANALYSIS

		AIRCRAFT TYPE 1	2	3	5	7	8	9	11	12	13
	LEASE	2461.	3511.	14249.							
IV NON PRO	FINCE	2917.	4162.	17039.							
	OWN	3126.	4460.	18399.							
	LEASE	1606.	2292.	9269.	30321.		55369.			5023.	9360.
NON PRO	FINCE	2168.	3093.	12660.	35967.		65678.			5536.	12734.
	OWN	2472.	3527.	14549.						6279.	
RP											
	LEASE	21306.	21992.	29669.	55071.	115576.	82219.	158404.	168939.	30930.	36210.
PRO	FINCE	21869.	22793.	33060.	60717.	132039.	92528.	182414.	193634.	32356.	39634.
	OWN	22172.	23227.	34949.						33120.	

APPENDIX C

COST SENSITIVITY RELATIONSHIPS
FOR INDIVIDUAL USER SUBCATEGORIES

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE I

AIRCRAFT TYPE

	1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	345	60.95	8.34	830	59.07	13.01	3367	49.20	14.02
A/F & AV	127	22.35	3.06	338	24.04	5.30	1757	25.68	7.32
Eng	95	16.70	2.28	237	16.89	3.72	1718	25.11	7.15
Total	567		13.68	1405		22.03	6842		28.49
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	2461	68.77	59.37	3511	70.60	55.04	14,248	82.95	59.32
Hull Ins	575	16.08	13.88	729	14.67	11.44	1581	9.20	6.58
Med & Lia Ins	112	3.13	2.70	196	3.94	3.07	230	1.34	0.96
Hangar, Etc.	355	9.91	8.55	408	8.21	6.40	890	5.18	3.71
Fed Fee	16	0.45	0.39	49	0.98	0.76	95	0.55	0.39
Misc	59	1.66	1.44	80.0	1.61	1.25	133	0.77	0.55
Total	3578		86.32	4973		77.97	17,177		71.51
Grand Total	4145			6378			24,019		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE II

AIRCRAFT TYPE

	1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	345	60.95	7.51	830	59.07	11.81	3367	49.20	12.56
A/F & AV	127	22.35	2.75	338	24.04	4.81	1757	25.68	6.56
Eng	95	16.70	2.06	237	16.89	3.38	1718	25.11	6.41
Total	567		12.32	1405		19.99	6842		25.52
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	2917.	72.30	63.39	4162	74.00	59.21	17,038	85.33	63.55
Hull Ins	575	14.26	12.50	729	12.97	10.38	1581	7.92	5.90
Med & Lia Ins	112	2.78	2.43	196	3.48	2.79	230	1.15	0.86
Hangar, Etc.	355	8.79	7.71	408	7.26	5.81	890	4.46	3.32
Fed Fee	16	0.40	0.35	49	0.86	0.69	95	0.47	0.35
Misc	59	1.47	1.29	80	1.42	1.44	133	0.67	0.50
Total	4034		87.68	5624		80.01	19,967		74.48
Grand Total	4601			7029			26,809		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE III

AIRCRAFT TYPE

	1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	345	60.95	7.18	830	59.07	11.33	3367	49.20	11.95
A/F & AV	127	22.35	2.63	338	24.04	4.61	1757	25.68	6.24
Eng	95	16.70	1.97	237	16.89	3.24	1718	25.11	6.10
Total	567		11.79	1405		19.18	6842		24.29
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	3126	73.67	64.98	4460	75.31	60.86	18,398	86.27	65.31
Hull Ins	575	13.56	11.96	729	12.32	9.96	1581	7.41	5.61
Med & Lia Ins	112	2.64	2.33	196	3.31	2.67	230	1.08	0.82
Hangar, Etc.	355	8.36	7.37	408	6.89	5.57	890	4.17	3.16
Fed Fee	16	0.38	0.33	49	0.82	0.66	95	0.44	0.34
Misc	59	1.40	1.24	80	1.35	1.09	133	0.62	0.47
Total	4243		88.21	5922		80.82	21,327		75.71
Grand Total	4810			7327			28,169		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE IV

AIRCRAFT TYPE

	1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	270	60.95	9.24	648	59.06	14.31	2630	49.20	15.56
A/F & AV	99	22.35	3.39	264	24.04	5.82	1373	25.69	8.12
Eng	74	16.70	2.53	186	16.89	4.09	1342	25.11	7.94
Total	443		15.16	1098		24.23	5345		31.62
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	1606	64.78	54.96	2292	66.73	50.57	9269	80.20	54.84
Hull Ins	449	18.13	15.38	570	16.60	12.58	1235	10.69	7.31
Med & Lia Ins	87	3.53	2.99	153	4.45	3.38	180	1.56	1.06
Hangar, Etc.	277	11.17	9.48	319	9.29	7.04	695	6.02	4.11
Fed Fee	13	0.50	0.43	38	1.11	0.84	74	0.64	0.44
Misc	47	1.88	1.59	62	1.82	1.38	104	0.90	0.62
Total	2479		84.84	3434		75.77	11,557		68.38
Grand Total	2922			4532			16,902		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE IV

AIRCRAFT TYPE

	6.						8.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	9092	44.94	15.57				40,010	60.19	29.46
A/F & AV	5483	27.10	9.33				14,473	21.77	10.66
Eng	5656	27.96	9.62				11,992	18.04	8.83
Total	20,231		34.41				66,475		48.95
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	30,321	78.64	51.58				55,369	79.86	40.77
Hull Ins	4681	12.14	7.96				6227	8.98	4.59
Med & Lia Ins	750	1.95	1.28				690	1.00	0.51
Hangar, Etc.	1416	3.67	2.41				4553	6.57	3.35
Fed Fee	204	0.53	0.35				307	0.44	0.23
Misc	1184	3.07	2.01				2186	3.15	1.61
Total	38,556		65.59				69,332		51.05
Grand Total	58,787						135,807		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE IV

AIRCRAFT TYPE

	12.			13.					
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	879	32.25	7.74	2287	27.15	9.26			
A/F & AV	1369	50.19	12.05	2924	34.71	11.85			
Eng	479	17.56	4.22	3212	38.14	13.01			
Total	2727		24.01	8423		34.12			
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	5023	58.20	44.22	9360	57.56	37.92			
Hull Ins	3045	35.28	26.81	5987	36.82	24.26			
Med & Lia Ins	175	2.03	1.54	330	2.03	1.34			
Hangar, Etc.	312	3.62	2.75	413	2.54	1.68			
Fed Fee	15	0.17	0.13	69	0.42	0.28			
Misc	61.0	0.71	0.54	102	0.63	0.41			
Total	8631		75.99	16,261		65.88			
Grand Total	11,358			24,684					

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE V

AIRCRAFT TYPE

	1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	270	60.95	7.75	648	59.06	12.16	2630	49.20	12.96
A/F & AV	99	22.35	2.84	264	24.04	4.95	1373	25.69	6.77
Eng	74	16.70	2.12	186	16.89	3.48	1342	25.11	6.62
Total	443		12.72	1098		20.59	5345		26.34
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	2168	71.29	62.23	3093	73.03	57.99	12,660	84.69	62.38
Hull Ins	449	14.78	12.90	570	13.46	10.69	1235	8.26	6.09
Med & Lia Ins	87	2.88	2.51	153	3.61	2.87	180	1.20	0.89
Hangar, Etc.	277	9.11	7.95	319	7.53	5.98	695	4.65	3.43
Fed Fee	13	0.41	0.36	38	0.90	0.71	74	0.50	0.36
Misc	47	1.53	1.33	62	1.48	1.17	104	0.70	0.51
Total	3041		87.28	4235		79.41	14,948		73.66
Grand Total	3484			5333			20,293		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE V

AIRCRAFT TYPE

	6.						8.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	9092	44.94	14.11				40,010	60.19	27.38
A/F & AV	5483	27.10	8.51				14,473	21.77	9.90
Eng	5656	27.96	8.78				11,992	18.04	8.21
Total	20,231		31.40				66,475		45.49
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	35,967	81.37	55.82				65,678	82.47	44.95
Hull Ins	4681	10.59	7.26				6227	7.82	4.26
Med & Lia Ins	750	1.70	1.16				690	0.87	0.47
Hangar, Etc.	1416	3.20	2.20				4553	5.72	3.12
Fed Fee	204	0.46	0.32				307	0.38	0.21
Misc	1184	2.68	1.84				2186	2.75	1.50
Total	44,202		68.60				79,641		54.51
Grand Total	64,433						146,116		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE V

AIRCRAFT TYPE

	12.			13.					
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	879	32.25	7.43	2287	27.15	8.14			
A/F & AV	1369	50.19	11.56	2924	34.71	10.40			
Eng	479	17.56	4.05	3212	38.14	11.43			
Total	2727		23.03	8423		29.97			
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	5506	60.41	46.50	12,784	64.94	45.48			
Hull Ins	3045	33.41	25.71	5987	30.42	21.30			
Med & Lia Ins	175	1.92	1.48	330	1.68	1.17			
Hangar, Etc.	312	3.43	2.64	413	2.10	1.47			
Fed Fee	15	0.16	0.12	69	0.35	0.24			
Misc	61	0.67	0.52	102	0.52	0.36			
Total	9114		76.97	19,685		70.03			
Grand Total	11,841			28,108					

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VI

	AIRCRAFT TYPE 1.			AIRCRAFT TYPE 2.			AIRCRAFT TYPE 3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	270	60.95	7.13	648	59.06	11.24	2630	49.20	11.86
A/F & AV	99	22.35	2.61	264	24.04	4.58	1373	25.69	6.19
Eng	74	16.70	1.95	186	16.89	3.22	1342	25.11	6.05
Total	443		11.69	1098		19.04	5345		24.10
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	2472	73.90	65.26	3527	75.53	61.15	14,549	86.41	65.59
Hull Ins	449	13.44	11.87	570	12.21	9.88	1235	7.33	5.57
Med & Lia Ins	87	2.62	2.31	153	3.28	2.65	180	1.07	0.81
Hangar, Etc.	277	8.28	7.31	319	6.83	5.53	695	4.13	3.14
Fed Fee	13	0.37	0.33	38	0.81	0.66	74	0.44	0.33
Misc	47	1.39	1.23	62	1.34	1.08	104	0.62	0.47
Total	3345		88.31	4669		80.96	16,837		75.90
Grand Total	3788			5767			22,182		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VI

AIRCRAFT TYPE

	12.								
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	879	32.25	6.97						
A/F & AV	1369	50.19	10.85						
Eng	479	17.56	3.80						
Total	2727		21.62						
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	6279	63.51	49.78						
Hull Ins	3045	30.80	24.14						
Med & Lia Ins	175	1.77	1.39						
Hangar, Etc.	312	3.16	2.48						
Fed Fee	15	0.15	0.11						
Misc	61	0.62	0.48						
Total	9887		78.38						
Grand Total	12,614								

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VII

AIRCRAFT TYPE

	1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	270	60.95	1.19	648	59.06	2.68	2630	49.20	7.05
A/F & AV	99	22.35	0.44	264	24.04	1.09	1373	25.69	3.68
Eng	74	16.70	0.33	186	16.89	0.77	1342	25.11	3.60
Total	443		1.96	1098		4.53	5345		14.33
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	21,306	96.06	94.18	21,992	95.06	90.75	29,669	92.84	79,54
Hull Ins	449	2.03	1.99	570	2.46	2.35	1235	3.86	3.31
Med & Lia Ins	87	0.40	0.39	153	0.66	0.63	180	0.56	0.48
Hangar, Etc.	277	1.25	1.22	319	1.38	1.32	695	2.18	1.86
Fed Fee	13	0.06	0.06	38	0.16	0.16	74	0.23	0.20
Misc	47	0.21	0.21	62	0.27	0.26	104	0.33	0.28
Total	22,179		98.04	23,134		95.47	31,957		85.67
Grand Total	22,622			24,232			37,302		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VII

AIRCRAFT TYPE

	6.			7.			8.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	9092	44.94	10.88	42,018	50.94	19.00	40,010	60.19	24.60
A/F & AV	5483	27.10	6.56	34,358	41.66	15.53	14,473	21.77	8.90
Eng	5656	27.96	6.77	6102	7.40	2.76	11,992	18.04	7.37
Total	20,231		24.22	82,478		37.29	66,475		40.87
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	55,071	86.99	65.92	115,576	83.33	52.26	82,219	85.48	50.55
Hull Ins	4681	7.39	5.60	11,250	8.11	5.09	6227	6.47	3.83
Med & Lia Ins	750	1.18	0.90	1800	1.30	0.81	690	0.72	0.42
Hangar, Etc.	1416	2.24	1.70	6162	4.44	2.79	4553	4.73	2.80
Fed Fee	204	0.32	0.24	708	0.51	0.32	307	0.32	0.19
Misc	1184	1.87	1.42	3200	2.31	1.45	2186	2.27	1.34
Total	63,306		75.78	138,696		62.71	96,182		59.13
Grand Total	83,537			221,174			162,657		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VII

AIRCRAFT TYPE

	9.			11.			12.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	57,965	49.96	19.49	90,354	57.69	25.81	879	32.25	2.36
A/F & AV	37,831	32.61	12.72	37,547	23.98	10.73	1369	50.19	3.67
Eng	20,219	17.43	6.80	28,706	18.33	8.20	479	17.56	1.29
Total	116,015		39.00	156,607		44.74	2727		7.32
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	158,404	87.29	53.25	168,939	87.34	48.26	30,930	89.55	83.00
Hull Ins	12,032	6.63	4.04	11,250	5.82	3.21	3045	8,82	8.17
Med & Lia Ins	750	0.41	0.25	1970	1.02	0.56	175	0.51	0.47
Hangar, Etc.	5030	2.77	1.69	5918	3.06	1.69	312	0.90	8.84
Fed Fee	665	0.37	0.22	706	0.37	0.20	15	0.04	0.04
Misc	4591	2.53	1.54	4640	2.40	1.33	61.0	0.18	0.16
Total	181,472		61.00	193,423		55.26	34,538		92.68
Grand Total	297,487			350,030			37,265		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VII

AIRCRAFT TYPE

	13.								
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	2287	27.15	4.44						
A/F & AV	2924	34.71	5.67						
Eng	3212	38.14	6.23						
Total	8423		16.35						
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	36,210	83.99	70.26						
Hull Ins	5987	13.89	11.62						
Med & Lia Ins	330	0.77	0.64						
Hangar, Etc.	413	0.96	0.80						
Fed Fee	69	0.16	0.13						
Misc	102	0.24	0.20						
Total	43,111		83.65						
Grand Total	51,534								

119<

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VIII

	AIRCRAFT TYPE 1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	270	60.95	1.16	648	59.06	2.59	2630	49.20	6.46
A/F & AV	99	22.35	0.43	264	24.04	1.05	1373	25.69	3,37
Eng	74	16.70	0.32	186	16.89	0.74	1342	25.11	3.30
Total	443		1.91	1098		4.39	5345		13.14
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	21,868	96.16	94.32	22,793	95.23	91.05	33,060	93:53	81,24
Hull Ins	449	1.98	1.94	570	2.38	2.28	1235	3.49	3.03
Med & Lia Ins	87	0.38	0.38	153	0.64	0.61	180	0.51	0.44
Hangar, Etc.	277	1.22	1.19	319	1.33	1.27	695	1.97	1.71
Fed Fee	13	0.05	0.05	38	0.16	0.15	74	0.21	0.18
Misc	47	0.20	0.20	62	0.26	0.25	104	0.29	0.26
Total	22,741		98.09	23,935		95.61	35,348		86.86
Grand Total	23,184			25,033			40,693		

CASE VIII

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

AIRCRAFT TYPE

	6.			7.			8.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	9092	44.94	10.19	42,018	50.94	17.68	40,010	60.19	23.13
A/F & AV	5483	27.10	6.15	34,358	41.66	14.46	14,473	21.77	8.37
Eng	5656	27.96	6.34	6,102	7.40	2.57	11,992	18.04	6.93
Total	20,231		22.69	82,478		34.71	66,475		38.43
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	60,717	88.06	68.08	132,039	85.10	55.56	92,528	86.89	53.49
Hull Ins	4681	6.79	5.25	11,250	7.25	4.73	6227	5.85	3.60
Med & Lia Ins	750	1.09	0.84	1800	1.16	0.76	690	0.65	0.40
Hangar, Etc.	1416	2.05	1.59	6162	3.97	2.59	4553	4.28	2.63
Fed Fee	204	0.30	0.23	708	0.46	0.30	307	0.29	0.18
Misc	1184	1.72	1.33	3200	2.06	1.35	2186	2.05	1.26
Total	68,952		77.31	155,159		65.29	106,491		61.57
Grand Total	89,183			237,637			172,966		

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE VIII

AIRCRAFT TYPE

	9.			11.			12.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	57,965	49.96	18.03	90,354	57.69	24.11	879	32.25	2.27
A/F & AV	37,831	32.61	11.77	37,547	23.98	10.02	1369	50.19	3.54
Eng	20,219	17.43	6.29	28,706	18.33	7.66	479	17.56	1.24
Total	116,015		36.09	156,607		41.79	2727		7.05
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	182,414	88.77	56.74	193,634	88.77	51.67	32,356	89.97	83.63
Hull Ins	12,032	5.86	3.74	11,250	5.16	3.00	3045	8.47	7.87
Med & Lia Ins	750	0.36	0.23	1970	0.90	0.53	175	0.49	0.45
Hangar, Etc.	5030	2.45	1.56	5918	2.71	1.58	312	0.87	0.81
Fed Fee	665	0.32	0.21	706	0.32	0.19	15	0.04	0.04
Misc	4591	2.23	1.43	4640	2.13	1.24	61	0.17	0.16
Total	205,482		63.91	218,118		58.21	35,964		92.95
Grand Total	321,497			374,725			38,691		

CASE VIII

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

AIRCRAFT TYPE

	13.								
Variable Cost	**$/YR**	**% VC**	**% TC**	**$/YR**	**% VC**	**% TC**	**$/YR**	**% VC**	**% TC**
Fuel & Oil	2287	27.15	4.16						
A/F & AV	2924	34.71	5.32						
Eng	3212	38.14	5,85						
Total	8423		15,33						
Fixed Costs	**$/YR**	**% FC**	**% TC**	**$/YR**	**% FC**	**% TC**	**$/YR**	**% FC**	**% TC**
A.I.	39,634	85.17	72.12						
Hull Ins	5987	12.87	10.89						
Med & Lia Ins	330	0.71	0.60						
Hangar, Etc.	413	0.89	0.75						
Fed Fee	69	0.15	0.12						
Misc	102	0.22	0.19						
Total	46,535		84.67						
Grand Total	54,958								

COST SENSITIVITY RELATIONSHIPS - AFTER TAX - 1972 DATA

CASE IX

AIRCRAFT TYPE

	1.			2.			3.		
Variable Cost	$/YR	% VC	% TC	$/YR	% VC	% TC	$/YR	% VC	% TC
Fuel & Oil	270	60.95	1.15	648	59.06	2.55	2630	49.20	6.18
A/F & AV	99	22.35	0.42	264	24.04	1.04	1373	25.69	3.22
Eng	74	16.70	0.32	186	16.89	0.73	1342	25.11	3.15
Total	443		1.89	1098		4.31	5345		12.55
Fixed Costs	$/YR	% FC	% TC	$/YR	% FC	% TC	$/YR	% FC	% TC
A.I.	22,172	96.21	94.40	23,227	95.31	91.20	34,949	93.85	82.07
Hull Ins	449	1.95	1.91	570	2.34	2.24	1235	3.32	2.90
Med & Lia Ins	87	0.38	0.37	153	0.63	0.60	180	0.48	0.42
Hangar, Etc.	277	1.20	1.18	319	1.31	1.25	695	1.87	1.63
Fed Fee	13	0.05	0.05	38	0.16	0.15	74	0.20	0.17
Misc	47	0.20	0.20	62	0.26	0.25	104	0.28	0.24
Total	23,045		98.11	24,369		95.69	37,237		87.45
Grand Total	23,488			25,467			42,582		